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LAKE TANA AND ITS ISLANDS: *A paper read at the Evening Meeting of the Society on 18 February 1935, by*

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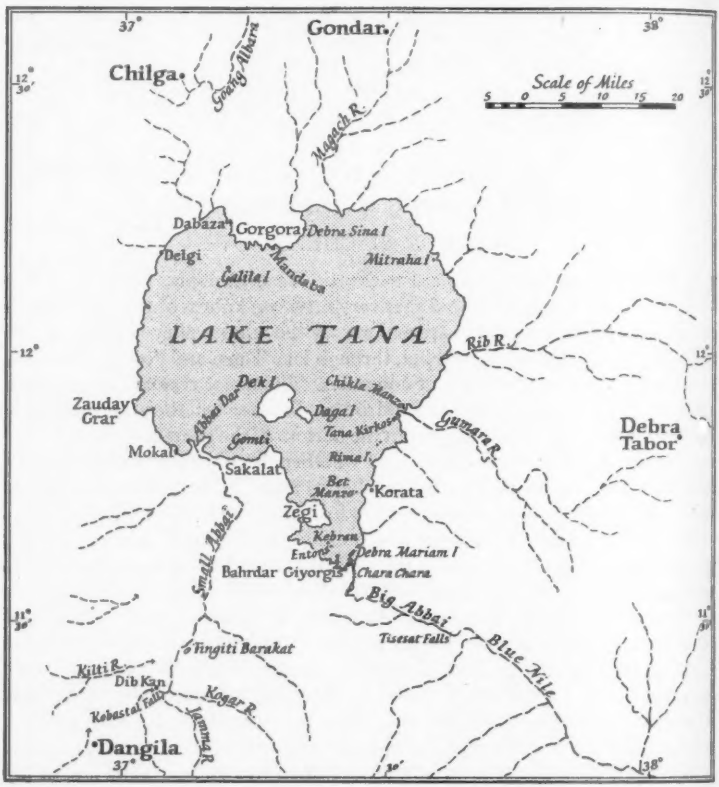
WHEN I was first appointed to North West Ethiopia, in 1925, as His Majesty's Consul, I found that very little was known of the Blue Nile in Abyssinia, and determined to see and survey the whole valley from its source at the Sacred Spring at Gish Abbai, through lake Tana, and down to Roseires in the Sudan, a distance of about 600 miles. The major results that could be expected from such a journey would be to discover whether there was any level land which could be irrigated in the bottom of the great canyon; whether there were any lakes down there; and whether there were any sites suitable for a dam and reservoir. I wished further to make a compass traverse of the valley, checked by observations on stars for latitude; to take a series of levels of the river by aneroid readings and boiling-point tests at intervals on the water-edge, and to close them on the nearest known level, the top of the Nile Gauge at Roseires, which would connect them to the Sudan Surveys and to sea-level at the Mediterranean. I wished also to ascertain whether the fall of some 8000 feet between the source and Roseires, and more particularly the fall of 4510 feet between lake Tana and Roseires, was in big falls and long level reaches, or a gradual fall distributed throughout the whole length: that is, to obtain a longitudinal section of the river. These objects have all been achieved, but not in one or even two journeys: it has occupied over eight years.

My first idea was to take an iron canoe which was on lake Tana and in my charge, and to follow the river; but the number of cataracts in the first 20 miles below lake Tana showed this to be impracticable. I then tried another plan and started to follow along the water-edge by mule caravan and on foot, a method which looked feasible on what maps were available. After about 70 miles of this, which was much like going up and down the teeth of a comb, my passage was barred by precipices coming down to the water-edge. For the rest of the high mountainous part I followed the valley, dropping down at intervals to the water to read the aneroid, until in the last 140 miles to Roseires it was possible once more to travel along the water-edge. Aneroid readings of the water-level were obtained at some thirty points in all. This part of the

work was done on two expeditions, in 1927 and 1929, which I have called the first and second reconnaissances of the Big Abbai. I had the honour of being invited to give the results of the work done in 1927, and I did this in a paper kindly read on my behalf before this Society on 21 November 1927, by Colonel H. S. L. Winterbotham, as I was on my way back to Abyssinia at the time.

By 1932 there remained but a section of 30 miles in the lower half of the



Neighbourhood of Lake Tana, Abyssinia

Small Abbai river and a journey round lake Tana by water to complete my self-imposed task, and it is this that I am about to describe to you. Before beginning I must refer back to my paper on the first Abbai reconnaissance read on 21 November 1927, when two questions were put in the discussion which followed, that have, as I was not present, remained unanswered. The first was raised by the President, Sir Charles Close, and referred to my spelling of Tana. The Permanent Committee on Geographical Names has decided that Tana and not Tsana is the correct transliteration from the Amharic

word, as written; they have published it in their list, and I have followed their ruling.

The second was in a letter from Mr. G. W. Grabham, which was read at the meeting, in which he protested against my use of the word "rift" or "tectonic" in describing the Blue Nile Valley. In it he mentioned that he had written to me. My omission to refer to his letter in my paper is to be explained by the fact that it followed me round and reached me several weeks later in Africa. Had I had the advantage of reading it before writing the paper I should have qualified my words and remarks somewhat, as tectonic and rift have acquired a definite interpretation as applied to valleys. I meant to convey the impression that I believed the valley had formed the river and not the river the valley. Since then I have seen the whole canyon and cannot agree that it is the result of erosion. The lava cap that forms the whole of the Abyssinian plateau is the result of a gigantic volcanic upheaval, which left immense mountains, valleys, and crevasses, and the heavy rains have run down the mountain slopes to the bottom and have flowed round into crevasses eventually getting below the basalts to the limestones and sandstones underneath. I can agree that the erosion that has been going on since has considerably altered the valleys' shapes and conformation on orthodox lines; of that there is ample evidence.

I left Dangila Consulate on 21 November 1932 for lake Tana. The Sudan Government had given me permission to use the Consulate staff, mules, caravan, and equipment, and His Majesty's Minister, Sir Sidney Barton, had obtained a permit from the Emperor Haile Silasi allowing me to travel on the waters of the lake and visit the islands. I carried personal letters to all subordinate chiefs through whose territories round the shore we had to pass. I had verbal permission to enter the monasteries only if the Abbots chose to let me. That is to say, it was left to the priesthood to refuse me if they wished. Acting on the advice of the late Sir Wallis Budge, who had been of great assistance to me up to the time of his last illness, I was not going to waste time in being critical. He wished me to collect all the folk-lore and legends of the priests, accepting them without question, as he wanted to read the stories just as they were told to me.

I had ordered tankwas, or reed rafts, to be built in Zegi and to meet me near the estuary of the Small Abbai. Tankwas are the only craft plying on the lake. They are made and propelled by Waito tribesmen, who are probably an Hamitic people who arrived on the Abyssinian plateau before the Amhara Abyssinians. The rafts are bundles of papyrus bound together and streamlined into boat shape. They cost eight shillings each and become water-logged in a fortnight. They are heavy to propel, and after a fortnight soon sink if not renewed or repaired with dry reeds. I ordered two, but eventually had to add a third to take all my baggage. Waitos are now converted to Muhammadanism and speak Amharic. Their original language and the rites and ceremonies of their old beliefs are forgotten. The cult of the hippopotamus is one of the few survivals of ancient custom; they eat the flesh and no man can marry until he has killed one. I found them hard workers, of cheerful and contented disposition, and great hunters and fishermen.

On the way to the lake it was possible, without going far out of the way, to

follow the Small Abbai and chart a section of 30 miles in the lower half of its course, filling in the positions of its tributaries, which were in a state of confusion on maps. We struck the river at Dib Kan, where three of the largest tributaries join the main stream. First the Ashar, not shown on published maps; next the Jama (I have had to alter the map position of its mouth by some 6 miles); and then the Kogar. The Small Abbai in Dib Kan parish has two sheer falls of 30 feet, each over cliffs of basalt.

We left Dib Kan on November 23, following the left bank of the Small Abbai closely, and camping beside the mouth of the Kilti river we spent the evening fixing its position by compass bearings. Two Kilti rivers, tentatively shown on maps as running parallel, proved when I got there to be only one.

Mapping the surrounding country here led to the discovery of a volcanic lake lying half a mile from the right bank of the river, which was not shown on maps, and of the existence of which I had never previously heard. The local people called it Tingiti Barakat, which means Shining Tingiti. There is no inlet or outlet; it lies in a basalt basin or depression level with the banks of the Small Abbai. In the annual rainy season the river overflows and the whole depression becomes a lake; then, as the river falls, land near it becomes exposed, leaving a permanent circular lake at the far side full to the brim and about a mile in diameter. A remarkable feature was a deposit of white sand along the south shore; it was not in any quantity, but it is the only white sand I have seen in Abyssinia. Dr. Campbell Smith, of the British Museum of Natural History, to whom I sent all my geological specimens for identification, says it is very fine white sand consisting of crystals of quartz and fragments of feldspar. Its origin, though not obvious, was possibly disintegration of rocks of a ridge of white quartz-trachyte with which the lake water comes in contact. The water was blue and seemed very deep, only a narrow fringe of reeds encircling the edge.

For the next two days we followed the left bank of the Small Abbai, filling in detail. The track was not easy to find and the natives were aloof and not helpful. We had now reached Dambi Ford and had completed the 30 miles I wanted. The river downstream of this had been seen by Europeans as far as the lake, so when the chief residing in the last reaches showed signs of being difficult and ordered the two tankwas that had come to meet me off his land, I wasted no time over him but crossed to the right bank and went straight to the lake shore at Lijomi, which was not under his jurisdiction and where the tankwas were waiting; and I determined to go by water and see him to call his bluff.

Lijomi has a church on a mound about 200 feet high, beautifully situated, with views over the lake. Land was pointed out here that at one time was permanently under water and which now is cultivated land, never flooded even at high lake. This led me to the discovery, of which I had ample proof later, that the lake high-water level has fallen from 4 to 6 feet in the last three hundred years. Whether it took place suddenly or by degrees cannot be stated, but it is a generally accepted tradition all round the lake that the water has receded. Major L. B. Roberts, of the J. G. White Engineering Corporation of New York, who was surveying on lake Tana the following winter and to whom I pointed this out, has, he tells me, been able to confirm my view.

Tankwas returning from Rima, Lake Tana

Tana Kirkos Island, from the lake

Waito tribesmen at Balas, Lake Tana

The Blue Nile Gauge at Roseires

The bell-tower at Narga Silasi

The Blue Nile at the Second Nile Bridge

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From Lijomi my original plans had been laid to go eastward, then up the east coast, and so round the lake to my starting-point; but as I wanted to examine the mouth of the Small Abbai, which can only be done by water, it seemed better to make a preliminary journey starting westward, go all round the river estuary by tankwa, call on the unfriendly chief whose village lay at Mokal on the lake shore beyond the estuary, and come back. The Waitos said we could easily do all this in a day and return to Lijomi before sunset; so leaving the camp standing we started before dawn with a small party of men and two tankwas.

Heavy silt coming down the Small Abbai has been deposited as mud on each bank, and it seems that the river has in the course of time thrown out two narrow promontories extending 2 to 3 miles into the lake. The actual outflow cannot be seen from land as it is concealed in dense papyrus beds. Major Powell-Cotton got as far as he could along one of the promontories, and his is the only account of the Small Abbai in the area that I have been able to find. Several other rivers discharge into the lake under seemingly similar conditions, although the Small Abbai is the biggest, yet none of the others have this peculiar formation of promontories even in proportionate degree, so another less obvious origin may have to be found for the parallel peninsulas.

I soon realized we were going to be late on our day's programme as the Waitos punted industriously along the shore following every curve at a speed of one mile an hour. Their only oar is a length of bamboo, and once the tankwa is in deep water, if an unfavourable breeze rises, the raft is likely to be blown "out to sea," so they prefer to punt in shallows not more than 12 feet deep.

There are three hamlets on the promontories: Waito Menda, a Waito village; Abbai Dar and Gilgil Abbai, Amhara villages. Gilgil Abbai is on an island, for the river has cut for itself a by-pass called Gilgil Abbai, meaning Child of Abbai, through the left-bank promontory, leaving the last mile or so completely cut off from land. We eventually arrived at the end and rounded the point, forcing our way through among the papyrus until we saw the outflow of the water. It was not discharging much silt in November, but to seaward was an extensive bar over which shallow water flowed for a long distance. The river channel was a lane of deep water, clear of papyrus and 150 feet wide, coming out from the forest of papyrus. This continual deposit is in fact silting up the lake, but the area of water is so vast that engineers who have studied the subject declare that there is no danger of its ever having much effect. The value of the lake as a reservoir is even enhanced by it, as the water comes in silt-laden and flows out clear at Chara-Chara, which gives it an advantage over other reservoirs on the Blue Nile, where silt-clearance and prevention is one of the main problems.

From the river mouth I was glad to see the Waitos got out their rowing poles and we cut across the bay to the promontory at Mokal, with a following wind. Here we found the chief who, when faced with the inevitable, was inclined to make up for his former truculence and even offered to put us all up for the night. He said the wind was rising, the sun getting low, and he thought we should have a rough passage in the dark. I could not afford to lose another day, so decided to risk it. We had a terrible passage up the west bank of the Abbai promontory. Both tankwas were rocking and swaying in the gale,

and the motion, which resembles riding on the back of a snake, made some of my men sea-sick. A tankwa is supple and conforms to the shape of the waves, and till one gets accustomed to it it seems as if the bundles of reeds must be torn apart. The Waitos wanted to drive our tankwas into the reeds and await the falling of the wind, which is what they usually do; but we had no food, it was bitterly cold, and when we were accidentally driven into the reeds, as we frequently were, swarms of mosquitoes were disturbed and bit fiercely, so I decided to go on at all hazards. When we reached the Abbai mouth we were sheltered from the wind and waves and we anxiously waited for the other tankwa which had been lost sight of for an hour, but which after ten minutes loomed up out of the dark. For the rest of the way we were sheltered from the full force of the gale, and reached camp at 11 p.m.

Our next move was eastward to Gomti, the nearest point to Dek and Daga Islands, visible on the horizon 5 miles out to sea. Preparations had been made for a week's stay on the islands; tents and provisions had to be taken by tankwa, while the mules awaited us on the mainland. We left at dawn on December 8, a few days' delay having been caused by tankwa repairs. The rule of the wind can be more or less relied on: at dawn it is usually dead calm; as the sun gains power a gentle breeze called *Tabahi* blows from the land to the sea; about four hours after sunrise the wind begins to blow in the opposite direction and is called *Bahri*, or sea breeze; it increases gradually till about 3 p.m., when the waves are 18 inches high and white crested, and travel by tankwa is unpleasant; towards evening it tends to die down and often drops altogether. The warming of the land is apparently responsible for the Bahri, which rises as soon as the land becomes warmer than the water. I asked the head Waito what was happening in the very centre of the lake when the wind seemed to start blowing from all directions at once. He said he had seen it and it was a wonderful sight; that very few Waitos have ventured to cross the 30 miles of open sea, but for special inducements and in light and manageable tankwas it had been done.

As we crossed the 5 miles of water to Dek I took a series of soundings and found the bottom of the lake to incline downwards to the centre, with a gradual rise to the island. The deepest recorded was 35 feet 11 inches. The apparatus was a sea fishing-rod and strong line with a rock tied at the end, which was marked by a knot at each throw and the time written down. The line was then reeled up and measured with a tape measure. The slackening of the line and the touch of the rock on the bottom could be distinctly felt and the bottom seemed to be rock, not mud.

We landed at Gadna on the south shore of Dek. Stecker's map indicates that he made a short circuit within the island of Dek, and it shows two churches, but he leaves no description. He gives 72 metres (236 feet) as the greatest depth of water he obtained between Dek Island and the mainland, but I did not obtain soundings even approaching that there or indeed anywhere else round the lake. In fact my results rather tend to show that the lake is not very deep anywhere, although in the middle, say 10 miles from land, where no one has ever been so far, it may be.

Dek Island, 3 miles in diameter, is not, strictly speaking, monasterial land, so family life goes on; there are five churches, each has a small village nearby,

and there are a few other hamlets. Three quarters of the island is given up to plough, the chief crops being dagusa and teff, both dwarf millets. Plough-land is divided into plots of about an acre, separated from each other by narrow hedges of scrub forest and big trees. The base of the island is scoriaceous lava in cubes, which are exposed all round the shore and washed by the waves, and identified as vesicular olivine basalt. On the top is a thin layer of red soil derived from the decay of the basalts. The fauna consists chiefly of birds and butterflies that can fly the 5 miles. Animals, as may be expected, are almost absent, though I trapped two kinds of rat; big pythons are numerous in the reed beds and are sometimes found exhausted out at sea and have been known to land on tankwas as unwelcome passengers. Mosquitoes on the islands were very bad.

Reports did not lead me to expect to find any literature or art in any of the five churches. We had visited two of them when my interpreter became seriously ill; and as he could not travel back alone I had to abandon the expedition, cross the mainland, and take him to his family in Dangila. I now had no one to do the intricate interpreting required in reading old documents in Giz, or to run my caravan, so although the precious dry months were passing, I took my caravan a fortnight's journey to Gallabat to pick up a new interpreter. Here I was delayed three weeks over a trivial matter with an Abyssinian Customs official. In returning to Dangila, in order not to have a completely wasted period, I chose a new route, as I wanted to straighten up a section of the map which was hitherto uncharted country. It produced good results, as the courses of the Rahad and Dinder were crossed in their upper reaches and I was able to make alterations in the positions tentatively given them on maps; the Balas river, another considerable tributary of the Blue Nile, was found to be 30 miles from its map position.

We returned to Dek Island, where we landed once more on March 9, having left it on December 11. The remaining three churches were visited and found to contain nothing of particular interest. The following day we went by tankwa to Narga Silasi islet, which is 600 yards in diameter, the base scoriaceous lava blocks and the top thickly afforested. It is a monastery. We came in from the west, landing at a rock and mortar water-gate of two storeys, with arched windows and domed roof. The church precincts are surrounded by a rock wall. On the east there is an entrance gate with a bell tower above, reached by twenty steps. The bell weighs about 2 hundredweight, and has no inscription. The main entrance lies farther to the east and is another domed and arched water-gate approached by a rock causeway. The church and buildings were erected by Yetege Mentewab, the queen of the Emperor Bakaffa (A.D. 1721–1730[1]). As the architecture is European it is probable that it was the work of the descendants of the Portuguese soldiers and artisans left behind when the Jesuit fathers were expelled from the country in the seventeenth century. It is certainly influenced by the palaces of Gondar, which in style it much resembles.

I was shown some of the books, which may be older than the church, as a lady of high estate can obtain libraries from other churches. We could not

[1] All dates in brackets have been taken from 'A History of Ethiopia,' Sir Wallis Budge.

find the date in any, although in several the day and hour when they were written is mentioned. One was the 'Miracles of Christ,' which contained good paintings on parchment. Some of the miracles illustrated were those recorded in the New Testament, and others were added, especially during His childhood, where He is represented as walking up a sunbeam off which His companions fall. Another volume in parchment with leather binding was beautifully inscribed in Giz, with one illustration of the Virgin Mary and Child, the Child being held in her left arm, as in European pictures. I was not able to see the Mazgab, or register, which by order of the Papas, or bishop, is kept locked up and cannot be taken out unless all the people are gathered together: a wise precaution to safeguard sacred church properties against loss at the hands of dishonest priests or unscrupulous travellers.

On March 4 a two-hours' row in the tankwa took us to Daga Island lying three-quarters of a mile from the south-east corner of Dek. It is a volcanic cone 300 feet high, on the top of which is the Monastery of St. Stephen. The whole island is considered sacred, and the monks inhabiting it are the most rigid recluses of any in Abyssinia. No female is allowed to land, and the ban extends to cows and hens. Stecker remarks that he also was not permitted to go there as it was holy ground. A forest of tropical growth covers the hill and hides everything. The little food required by the monks comes from their lands on Dek.

The church is rectangular and modern, with the altar, chancel, and nave arranged as in English churches. The original church had been struck by lightning and burnt down. The Ikrbet, where church properties and books are kept, is a separate building, a masonry structure of rock and mortar of primitive design. The monks cannot open this without the presence of the Gebaz, a layman who holds the key. The office is hereditary and he lives on monastery land on Dek, but had come over by previous arrangement and turned the lock with an iron key. We found the room was quite dark and had to be lighted with a home-made wax taper, after a preliminary visit by a monk with a censer. It was crowded with ceremonial vestments of the priests, and church drums, and the books were brought out to the daylight. We spent some hours examining them. Each one had to be translated from Giz into Amharic, but we found no dates. There were several lists of kings, and I copied extracts. At the back of the same building are the mortal remains of seven Emperors: Yekuno Amlak (A.D. 1268–1283), who brought back the throne of Ethiopia to the Solomonic line; David I (1382–1411), during whose reign a portion of the True Cross was brought from Jerusalem to Ethiopia; Zara Yakob (1434–1468); Za Dengel [1] (1603–1604); Fasiladas (1632–1665), who was the builder of some of the palaces at Gondar; Fasiladas' little son Izur, a boy of seven, who reigned only six hours; and Bakaffa (1721–1730). They are in wooden coffins placed on shelves.

Some of the monks of the more austere life, who had not been off the island for fifty years, did not come from their cells to see me, but invited me to come and speak with them in their secluded retreat.

On March 15 we crossed to the mainland at Gomti, and arranged that for

[1] The priest said it was Sarsa Dengel (1563–1597), but see Tellez, p. 172; and I later saw the burial place of Sarsa Dengel on Rima Island.

the future as we went round the lake we would meet the mules at a prearranged camp every evening. With no detailed map of the coast it was not always easy to tell the men where this would be. We poled most of the way, travelling south past Zegi, and one night was spent on the mouth of the Imfraz river, hidden in beds of papyrus. I had crossed this river at a ford higher upstream on several occasions: it was a swift-running, clear stream at all seasons, but I had never found the source. This was discovered a year later in a volcanic lake, Kurt Bahr, shown on published maps, but not as the source of the Imfraz. The lake and the whole river's course is in the loose scoriaceous lava cubes, a most unexpected material to hold water. The native who told me of this showed me by throwing in weed that the water is indeed flowing out of the lake through the lava blocks and passing underground. He said it was subterranean for a mile or two, when it rises again to the surface.

Kebran Island is another monastery, with the Church of Gabriel. It contains the tomb of the Emperor Takla Haimanot I (A.D. 1706–1708). A hut contains a bell with an inscription in Giz, which is embossed on it and which tells that it was presented to the Church of Gabriel by the Emperor Fasiladas (1632–1665). There were also two bells each made of two long stone slabs, the longest 8 feet by 1 foot, and struck by a round stone; a third bell is made of three wooden clappers of timber boards. The Abbot is a very old man, and took a long time getting a few books to examine, but I was told this church has a good library.

We had to wait at Bahrdar Giyorgis for new tankwas to be built, and I had ample time to examine the lake outlet at Chara Chara cataract. The lake-level can only have been lowered by erosion of the sill of lava here. There are several channels carrying off the water in the low-lake season, and they are passing through depressions cut in the lava. One can imagine that in the flood, when rocks and trees are passing over, the wear on the top of the lava barrier is comparatively rapid, and the stories that I was continually hearing of the lake's fall round the shores could easily be accounted for here. Apart from this the difference annually between the lake high-water and low-water level is about 6 feet. The water finds its way out of the lake through a maze of reef-girt lagoons well hidden in tall papyrus. The open water above Chara Chara is Debra Mariam lagoon, partly enclosed from the lake by Debra Mariam Island. Water flows in through gaps to the north and south of the island. These gaps are among the many problems of the control of the water of lake Tana. Suggestions have been made to close them in with artificial banks, and in one scheme the south channel has been proposed as the site of a regulator.

Debra Mariam Church on the island was once famous as a monastery, and religious councils of importance have been held there, but it is now in bad repair. It remains in my memory as one of a few churches where a book with a date was seen, as one announced that it was written 963 years after the Martyrs.

A few hippopotami are left in lake Tana, but crocodiles, which are numerous in the Blue Nile, are absent and have not been known to pass the lake outlet. As there is no barrier which would prevent a crocodile's passage, it must be the water temperatures which limit their range, although the temperatures which I took with the object of explaining it, if possible, do not help much.

On March 29 we camped in the mouth of the Gelda river which has the normal semicircular mud bar out in the lake. Next morning we rowed to Bet Manzo Island, a forest-clad cone rising out of the water one mile from the mainland. The Church of Medhani Allam (Saviour of the World) is small. There are a few wall-paintings. Ganj Amba and Mahdera Sibhat islands we found deserted. Rima Island contained the Church of Medhani Allam, and the Emperor Sarsa Dengel (A.D. 1563–1597) is buried there. A blue-and-white porcelain jar, in which his entrails were brought from the Sudan, stands in the church. He died of fever at Sennar, where wars against the savages had taken him, and had made a request to be buried in Rima. There were some beautiful paintings in this church suggesting European artists or monks who had studied in Palestine. Two triptychs were particularly good in colour; the old gold background and reds are superb and look like lacquer.

On April 2 camp was pitched on level grazing land in the mouth of the Gumara river, the local name of the camp site being Ahun Wata: "Now it has come out." Here is another instance of land once flooded and now dry. I was told that formerly tankwas plied over it at all seasons. Our objective was Tana Kirkos Island, connected to the mainland now by a rock causeway at low lake, and therefore it is not quite correct to describe it as an island. In the days of Ahmad Gran, the Muhammadan invader killed in battle A.D. 1543, it was the mile or so of water here that prevented him from sacking the church.

At the northern end of Tana Kirkos Island is a large stratum of rock standing vertical, forming a wall 400 or 500 yards long which towers up 100 feet in the air, looking like a huge wall of masonry. It has been identified as olivine-bearing basalt. In all probability the island gives its name to the lake. Tradition, so strong that it cannot be ignored, relates that the island is the first resting-place of the Ark of the Covenant brought by Menelik I from the Temple in Jerusalem, and that it remained there several hundred years before being removed to Aksum. A bell tower contains a brass bell with an inscription in Giz saying that it was given in the reign of Iyoas I (1755–1767).

The history of the church is that the first building was erected about A.D. 333 by Abreha and Asbeha, two kings of Aksum, who ruled together and thought as one, and during whose reign it is almost certain that Frumentius brought Christianity to Abyssinia. The first half of the fourth century is the only date for the conversion that can be given with certainty. There are several church properties of outstanding historical interest. A heavy dark wood bludgeon was taken from Fersham Ali, one of the Ahmad Gran's generals, by Saint Kirkos when Kirkos was but a child. A staff with cross on the top belonged to the Emperor Gabra Maskal (about A.D. 550), who presented it to the church. A metal bowl of bronze or iron, now broken and a part lost, has on the outside an embossed inscription (incomplete) in Sabean letters one inch high, which I copied; it has been kindly translated into French by the *Académie des Inscriptions et Belles Lettres*, Paris. Its date is about the second or third century A.D., and it was a vessel used for offerings of first-fruits to the gods. It had two handles, one vertical and one horizontal, with a simple decoration of ears of wheat. The donor was of the tribe Giraban, known to have occupied the Hadhramaut. As to its history the *Académie des*

Inscriptions writes, and I have translated: "The inscription could well be originally Abyssinian. There have been found in Aksum a certain number of inscriptions specifically Sabean. If imported then it springs from Yemen, but it cannot have had a Palestinian origin." There were also the vestments of Yared Kahan, a deacon in the reign of Gabra Maskal, which are still used by priests in ceremonies connected with the Ark.

Three stone pillars about 5 feet high stand in the grounds of the church. They are sacrificial altars of the Israelite priests; circular basins are cut in the top in which the blood of the victims of sacrifice was caught and thence sprinkled on the people by a priest with a whisk. On the top of one altar is fixed a rod with a cross, placed there by Frumentius. These altars gave one of the very few glimpses that have ever been obtained into Ethiopian pre-Christian times.

On April 3 we went on up the east coast, stopping at the island of Chikla Manzo, with the ruins of the palace of the Emperor Iyasu. We camped on the mainland at Gumara Ras, the old mouth of the Gumara river. The old bed of the river can be plainly seen as a depression winding across the flat Fogara plain. It is now disused, the whole current discharging at the new mouth near Tana Kirkos, but it may serve as a spill when the banks of the Gumara overflow. The change of course seems to have some connection with the fall in lake levels. Inhabitants of Fogara agree that the whole plain, now grazing and plough-land, was once part of the lake and some of it has become permanently dry land within living memory.

We camped in the mouth of the Rib river. Both the Gumara and Rib have semicircular bars of deposited silt thrown out into the lake, with water 6 inches deep flowing over them. Stuck on the bar are whole trees brought down during the flood season.

Mitraha Island, farther up the east coast and half a mile from the shore, contains ruins of a big masonry church built by the Emperor John I (1667–1682), and the mausoleum of the Emperor Iyasu I (1682–1706). The first church built on the island by the Emperor David I (1382–1411) was burnt by Gran, and the Church of John and Iyasu's mausoleum were burnt by the Dervishes in the days of the Khalifa (1887). I was told that the site of the great battle in which the Muhammadan conqueror, Ahmad Gran, was finally defeated is at Gran Bar, between Abachara and Dunkaz, not far inland from Mitraha. Gran's grave and that of his horse are there. It was here that the fate of Abyssinia as a Christian nation was decided in 1543, the Abyssinian Emperor Claudius being helped by Portuguese musketeers.

We poled along the edge of the Dembea plain on the north shore of the lake, passing the estuary of the Magach river with its semicircular silt bar, to the mountainous promontory of Gorgora, where there were many islands to examine. Some had churches, and others had ruins. On a headland of the mainland stands the monastery of Mandaba. Its superior is an Abbot and there are 150 resident monks. The grounds are enclosed by a high wall and no woman is allowed inside the gate. The Abbot has the power of putting refractory monks in chains, and is all powerful in his own monastery. He said that if a man fleeing from justice rings the monastery bell and is given sanctuary, even the highest in the land cannot take him. Communal meals are cooked and

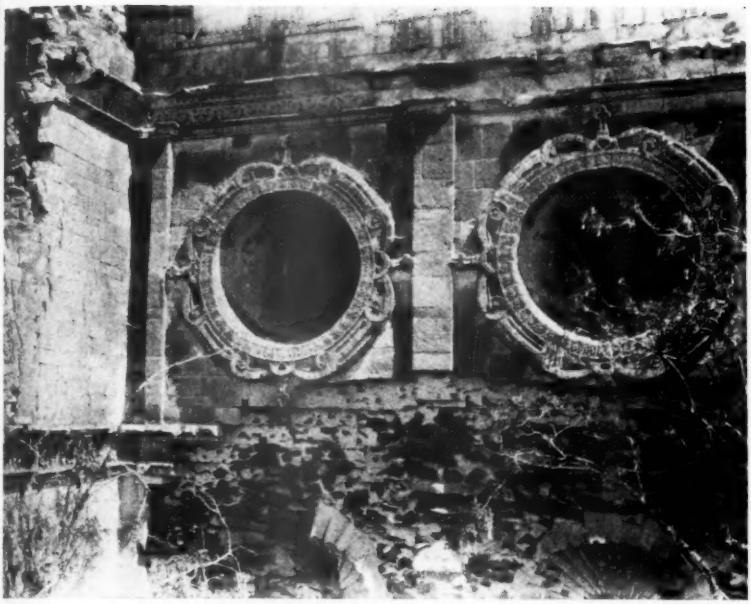
served, the bell rings, and monks can either eat in a common room or take their food to their cells. The financial support of the monastery is derived from rents and tithes from their own lands. Men enter as probationers and are called "black-heads." They serve the monks, but may be eventually accepted into the order, and are then allowed to wear the white skull-cap.

We rowed out 4 miles to Galila Island, a circular, forested cone at the south-west corner of Gorgora. Soundings were taken every fifteen minutes, the deepest reading being 43 feet at 100 yards from Galila shore. The lake-bottom was found to fall regularly to the island by roughly 2 feet every quarter of an hour. The monastery Church of Iyasus (Jesus) is on the top of the cone. It is a flourishing monastery. The Abbot invited me to partake of the lenten fare of the monks in a small room where they gather at sunset. After a short reading by the Abbot of a few verses from the Psalms of David in Giz, we were served with plain unleavened bread made of millet, with a small pile of powdered red pepper in which to dip the bread, and a bowl of chick-peas soaked and slightly roasted. The drink was a liquid made of the seed of *Nug*, a small sunflower-like plant, and mixed with water flavoured with red pepper.

To the west of Gorgora mainland, on a ridge several hundred feet high, stand the ruins of Gorgora palace, built for the Emperor Susenyos (1607-1632) by Pedro Paez, one of the Jesuit priests. The main wall of shaped white stone still stands. It is double, and a staircase ascends between the walls to the roof. The view of the lake and the mountains is magnificent. One side of the wall is sculptured to form part of a great hall; a portion of the arched roof is standing. Every part of stonework of the interior is decorated with carved patterns, and there are two rows of false windows, extending for the whole length of the wall, in rose pattern and shell pattern, which are particularly beautiful. The hall may have been a banqueting hall, or perhaps a chapel. The execution of the work is amazing, the more so that Pedro Paez had no skilled workmen to carry out his designs; he had even to make his tools himself, and the sculpture was done with his own hands.

The following day we moved to Dabaza, and during an evening stroll came by chance on huge caves and galleries, with the pick marks still on the walls, showing that it was here the stone was excavated for the palace. Specimens were reported on as "possibly silicified tuff." A procession of thirteen hyenas emerged from the cave at dusk and more were following, but I stampeded them by firing at the thirteenth.

During five days, in which the tankwas were once more in dock, we went by mule caravan to Chilga to see the *Isat Gamorra*—fire of Gamorra or volcano, which according to native reports had become active. It proved to be a fumarole, interesting chiefly because it is the only sign of volcanic activity, except hot springs, that I have seen or heard of on the Abyssinian highlands, although the plateau is composed of extinct volcanoes and lava rocks. The fissure out of which steam and sulphur fumes were continually issuing, was 6 inches wide and 3 feet long, but a few vents were smoking on each side, the whole smoke area being 8 yards long. The fumarole is on the side of a small tributary of the Goang or Atbara river. Both banks are cliffs cut in soft white rock, identified from specimens as white and pale grey vitric tuff.



Portuguese sculpture in the ruins of Gorgora palace

The abbot and monks of the Galila Island monastery

Fumarole fissure at Chilga

Tingiti Baraqat Lake from the Southern shore

On one bank is a layer of black material a foot thick, laid horizontal and forming a strange contrast to the white rock above and below. This dark seam was identified as lignite or brown coal.

The tankwas were ready for re-launching when we returned to the lake, and we passed round the north-west corner and down the west shore, finding only ruins of churches which had been sacked by the Dervishes and never rebuilt, so that beyond correcting map outlines of the shore it was a peaceful journey compared with the past.

On April 22 we turned the south-west corner and coasted along the south shore to Jigar, a forested headland with a church. The name of the church, Kadus Jigar, was the chief interest I found there. The priest said Jigar was a Syrian martyr who defended the child Christ when Herod was searching for Him, but so far I have not been able to find the name in any literature.

It was now only a short way to go to complete the circuit of the lake. On April 23 we poled round the next bay, passing the estuary of the Murfi river and on to Mokal Point, where I had landed on the previous December 1, before our adventurous night journey. On April 24, having paid off my Waito crew and presented them with the whole fleet of tankwas, we started by mule caravan back to Dangila.

It would have occupied too much time had I given here even the brief notes I made on the books and manuscripts seen in the libraries as we came to them, but the following list of titles extracted from my diary will perhaps be interesting. No attempt was made to make complete lists, nor to record the contents of books. They were all in Giz, and it is essentially the rôle of the specialist.

Mazgab	This Register is found in most churches and gives particulars of the church's foundation and history; some had details of transfers of land in the parish.
Arabitu Wangel	The four Gospels; of three copies at Galila Island one contained also some of the Galila churches' history.
Kebra Negest	Glory of Kings.
Terguami Wangel	Gospels, interpreted or abbreviated.
Orit	Old Testament.
Haimanot Abo	Faith of the Fathers.
Tamera Mariam	Miracles of the Virgin Mary.
Mashafa Hawi	Book of Hawi: religious law.
Af Work	Mouth of Gold.
Senkesar	Monograph of Saints, Martyrs, and Angels.
Sinodos	Acts of the Apostles.
Paulos	(St.) Paul.
Nebiat	Prophets.
Dirsana Mikael	Monograph of Michael, including Miracles of Rufail.

A calendar by Abu Shakr.
Gabra Himamat by Abu Shakr.
Book of Mysteries.
Monograph of Christ.
Book of the Gospels.
Miracles of Christ.

It was noticed that copies of the same book in different churches varied considerably. Copies of some of the above have found their way to Europe and have been translated; a summary of them will be found in the chapter on Abyssinian (Ethiopic) literature in 'A History of Ethiopia,' Sir Wallis Budge, p. 562.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: It is hardly necessary to introduce Major Cheesman, but I will remind you of his previous association with us. He was with me in Mesopotamia and when I left there he went in 1923 on an expedition in North-East Arabia and gave us a paper on the subject in 1924. Since then he has spent nine years at Dangila as the Consul on behalf of the Sudan Government on the Abyssinian frontier. During that time he made several trips to Lake Tana, regarding two of which he contributed a paper in 1927, and now this evening he will recount his experiences since then. Lake Tana has been for many years an important geographical feature. The Blue Nile practically rises there, passing in and out of the lake and making a great bend round to the southward until it joins the Nile at Khartoum. It is probable that at some period in the not distant future an important dam or regulator will be built to hold up its waters, when the need arises. I will now ask Major Cheesman to read his paper.

Major Cheesman then read the paper printed above, and a discussion followed.

The PRESIDENT: Mrs. Cheesman accompanied Major Cheesman on one of his trips on the lake. I am sure you would like to hear a word or two from her.

Mrs. CHEESMAN: I do not think I can add much to what my husband has told you. Until last year I was never allowed to accompany him any farther than Addis Ababa. However this year he took his courage and me in both hands and we went across Abyssinia together. It is marvellous country. I have been in Baluchistan as well as in Abyssinia, and in the former country I was impressed by the mountains, but I think those in Abyssinia are even more wonderful, and the views across Lake Tana are magnificent. I have only been a little way over the lake. I went in one of the tankwas. The water was oozing up through the bottom of the boat; a man put a bundle of reeds for me to sit on so that I might keep dry, and when he broke his pole he drew another bamboo out of the side of the ship, thus making another hole in it; but we continued our journey. I cannot tell you very much about the islands because I have not visited them, and you will remember that on one island not even a hen was allowed, so of course I was not allowed there; and I was not able to visit any of the churches on the islands.

There was however one other thing that I noted in Abyssinia: the beauty of the wild flowers. I believe an expedition is going out there shortly to make a collection. I only wish I had been able to do so, but I was usually too tired at the end of the day to do very much.

The PRESIDENT: We are short of travellers in that particular area, but Mr. Hobley is with us and Major Cheesman has raised one or two points on geology. Mr. Hobley knows the geology of the Rift Valley very well. That phenomenon seems to have some connection with the tract Major Cheesman has been dealing with, and I hope he will give us some observations from the geological point of view.

Mr. C. W. HOBLEY: I feel very diffident about saying anything with regard to Lake Tana because I have not been there, or very near it. Nevertheless it is a pleasure to be asked to speak because it gives me the opportunity of paying a

tribute to the marvellous work done by a succession of Consuls who have upheld British prestige on the borders of Abyssinia during the past twenty years. I have known a number of them: Sir Arnold Hodson was a notable example, and he has since achieved a great position; Major Athill, who is here to-night; Major Cheesman; Captain Whalley; and I cannot forget poor "Tich" Miles who a year ago was carried out desperately ill and, unfortunately, died soon after. There are others whose names I cannot remember just now. They are a fine body of men and they lead a very lonely existence in Abyssinia with no white men as companions and only a small force of Abyssinian soldiers. They are supposed to prevent slavery and all illicit practices, and they do a great deal in that direction. The solitude of their lives must be too appalling for words; this is a personal tribute I should like to pay to men, some of whom have been old colleagues of mine.

With regard to the geology of that part of Abyssinia I have read a certain amount; many of its features have some connection with the forces which formed the Rift Valley. The Rift Valley is, as you know, a subsidence of the Earth's crust which extends, it is believed, from the Sea of Galilee through the Dead Sea of Galilee right down southwards to near Beira. But up on the highlands to the west there is a great plateau which was rising throughout the Tertiary period or may be earlier. As it rose, cracks appeared in the plateau and masses of basalt, of which Major Cheesman has shown pictures, were extruded. It flowed over the plateau and caused great changes in the physiography. As a rough analogy, imagine what would happen in the Thames valley if between the north-eastern end of the Berkshire Downs and the western end of the Chilterns there was suddenly a great flow of basalt which blocked up the valley of the river; this great dam would behind it impound a lake which would extend westward towards the Cotswolds. I think that is what has happened in Abyssinia. A great outflow or basalt has taken place and has impounded a vast lake behind it, which is the Tana we have been hearing about. I have used the analogy of the Thames in England because I think it is convenient and may bring it home to us.

It is, I believe, now demonstrated that in early Pleistocene times there was a pluvial period which is now decreasing: at the moment there is a period of comparative desiccation. When this pluvial period was in existence the heavy rains exceeded the evaporation and the basin behind the dam became a great lake. As the period of heavy rain persisted, the lake filled and eventually overflowed at the lowest point. Thus you have the birth of the Blue Nile. The old drainage lines would be marked by the basalt flows and the new course may have followed some crack which occurred after the lava was extruded. As time went on, erosion took place and a canyon was cut out, because it is known that as land rises the cutting power of rivers is increased and canyons with vertical sides are often formed. There, I think, we have a rough picture of what has happened in the centre of Abyssinia, and it is to be hoped that in due course a regulator or barrage will be placed across the exit from the lake and that the water will again be raised for the benefit of the Sudan. I do not know whether the monasteries are likely to be submerged, but I hope not. At any rate, by raising the level of the lake some 15 or 20 feet it is probable that no harm will be done and a great reservoir of water will be impounded, so that in times of drought that remote lake in the centre of Abyssinia will become of great value to the cotton-growing lands of the Sudan and Egypt.

Major L. F. I. ATHILL: I am rather out of date with Abyssinia itself, and I was very envious when I came here to-night and saw all the fascinating photographs. They made me long to get back to Abyssinia.

One of the things as interesting to me as Abyssinia itself is the map of

Abyssinia; and I suppose that it is probably of some interest to you as Fellows of the Royal Geographical Society. I often notice in the books that I read about Abyssinia—and I even caught Major Cheesman out once or twice—references to the map as something which might be expected to be correct. It is regarded as rather funny that two rivers are shown where only one exists, and, of course, with an ordinary map that is so. But I was employed for a quite long time in compiling a handbook of Abyssinia, and in doing so I worked hand in glove with a very remarkable man, a draughtsman at the War Office, who was compiling the map which is to-day, I think, the best map which exists of Abyssinia. Major Cheesman knows a lot about one part of Abyssinia. Other people know a lot about other parts; but Mr. Scotland at the War Office, who I do not think has ever left England, I should say, without reserve, knows more about Abyssinia than any other living man. During ten years he read every book that had ever been written about Abyssinia, some being translated for him, others in the original. He followed every traveller across Abyssinia, backwards and forwards, and from his studies, with a very small network of a few rather inadequate boundary surveys and the railway that runs up the centre of Abyssinia, he compiled an extraordinarily good map. I followed some of those travellers with him and you have no idea how difficult it is. To begin with, they are guided by Abyssinians. If you are like Major Cheesman and have lived in the country for some time you know the tricks of your guide. He probably was never misled after the first two or three years. But the ordinary person who goes out there for a short time is constantly misled. His guide wants to visit a lady in a certain village. The traveller is going from village A to B; the lady lives in village C which is miles out of the way, and the guide takes him to C. Therefore the report of the route from A to B takes you through C!

The most extraordinary thing about a map compiled in such a way is not that it should be inexact, but that it should be near enough to exactitude to make detailed criticism possible.

In the course of my reading I noticed a very remarkable phenomenon. I expect there are people of many nations here to-night. I am not making any comparison of their virtues. But Abyssinia has been travelled over by very famous Frenchmen and Italians and a certain number of Englishmen. The Frenchmen, whose books Scotland and I had to read to get the geographical points, were extraordinarily fond of describing the beauties of the races through which they passed, especially the ladies. The Italian, whenever he saw a beautiful sight, was always impressed by a comparison with Italy. I remember following Bottego, a great explorer, through pages and pages until we got over a watershed and looked down on the valley of the Omo river, which was the one place I wanted to read about, but for eighteen pages after crossing that watershed he compared the landscape stretched before him with the beauties of Italy, which was very nice but rather troublesome for the compiler of the map. The Englishman was only interested in two things: one the performance of his cook—I gather that Major Cheesman's cook must have been drowned, because we have not heard any reference to him—and the other, stories of rhinoceros. I assure you that, out of about forty books, stories about cooks and rhinoceros occupied the greater part. I am afraid what I have told you is not very geographical, but it has a moral, and that is: if you go to Abyssinia, or any other part of the world, you should first of all learn the written language of the country. For instance the question of Tana and Tsana very much depends on how it is written in the Amharic language. If you have to compile a map you will find that different travellers visiting the same place will write it down in English in many and widely differing ways. Again, the native description of a geographical feature,

such as pass, foot-hill, spring or ford, is often recorded, through ignorance of the language, as the place-name of that feature. Lastly I would ask you to keep a private notebook in which to record the doings of your cook and your rhinoceros.

The PRESIDENT: I am sure that you realized, as the lecturer went along, the extraordinary amount of interest there is and how there seems to be an endless field for research in those islands and their churches on Lake Tana, if only you can get to them.

I noticed in some of the pictures of the environs of the monasteries that there were a number of small children about. I do not know whether any of the monks are married: one would gather from the pictures that they were. I should like to ask Major Cheesman that question, that is, whether celibacy is obligatory or not.[1] Another point which struck me was, as I have seen it in other places in the Middle East, the extraordinarily lasting work of the Portuguese in the sixteenth and the beginning of the seventeenth centuries. Here we have an example of their handiwork in the wonderful carved masonry on the ruins of Gorgora palace. Major Cheesman has spent nine years in Abyssinia; he knows the language well and has lost no opportunity of doing useful work, not only in the direction of travel but also in that of natural history, *e.g.* in collecting the fauna, whenever he got the opportunity, especially the birds, and in surveying a piece of country which was hardly surveyed at all. The results of his surveying activities during these travels are the basis of our latest map of that part of the world, so that we can congratulate him on having put in a very useful nine years. I am sure if it was not for the fact that he had acquired a great knowledge of the country and had keen interests in many directions, he would have found his time there very irksome. As it is, he has apparently enjoyed it thoroughly, the only trial being that during the last few years he has been unable to have Mrs. Cheesman with him except on this occasion at Dangila. At other times she has only been able to accompany him to Addis Ababa or Khartoum, and then return home and wait until he got leave once more. I am sure we can congratulate Major Cheesman on the good use he has made of his sojourn in Abyssinia, and look forward to his getting a post where he will be able to use his talents and the knowledge he has already gained. I ask you to join with me in thanking him very much indeed for his interesting lecture.

[1] Major Cheesman explained afterwards that the monks are allowed to marry once!

[Major Cheesman's surveys of Lake Tana and determinations of height along the whole length of the Blue Nile have been placed in the hands of the Survey Department at Khartoum, by whom the results will eventually be published. We have therefore illustrated the present paper only by the small sketch-map used for the lecture, which should serve as a sufficient guide to Major Cheesman's journey.—ED. *G.J.*]

THE ENCROACHING SAHARA: THE THREAT TO THE WEST AFRICAN COLONIES: *A paper read at the Evening Meeting of the Society on 4 March 1935, by*

PROFESSOR E. P. STEBBING

THERE are a number of colonies, British and French, situated on or to the south of the indefinite and indeterminate southern edge of the Eastern Sahara Desert. Conterminous with the boundary of the Sahara, or well within it, are the colonies of French Sudan; Haute Volta (French), with the Ivory Coast and Gold Coast to the south; Niger (French), with Nigeria to the south; and Lake Chad to the east with British Cameroons. Considerable parts of the French Colonies of Niger, Haute Volta (North), and French Sudan lie within the Sahara, while Southern Algeria is entirely within the desert. Portions of Northern Nigeria must now be held to lie within the problematical southern boundary line of the Sahara. If the Sahara is advancing south, all the colonies enumerated are threatened, to a variable degree, by the Great Desert.

In what does this threat consist; and what present-day evidence exists of this advance? During a recent journey through parts of West Africa my attention was attracted to this matter. I propose therefore to begin by detailing my own investigations, which began in that most interesting and fascinating French Colony, the Côte d'Ivoire.

In the coastal regions of the West African colonies the heavy tropical forest is termed Rain Forest; to the north of the Rain Forest the Mixed Deciduous High Forest takes its place, though, as is usual in changes of forest types, there is no hard and fast boundary line between the two; north of the deciduous high forest, or interspersed with it, are large areas of what is called Bush or Savannah Forest, or, in the French Colonies, *savane*. By analogy with India, where large tracts of a similar type of forest are found, as for example in the Central Provinces and neighbouring regions, the term savannah or *savane* is misapplied; for the so-called savannah forest in West Africa, over extensive areas in the Ivory Coast, Gold Coast, Haute Volta, Nigeria, and French Niger, is only varied forms of a degraded mixed deciduous forest.

It was in the Ivory Coast that my attention was first drawn to the nature of the so-called *savane*. I was asked why I wanted to go and see such useless forest tracts, when I had presumably come out to study real forests. I had been informed that I should get into *savane* at about Bwake and carry it with me to Dabakala, which was as far north as I was going in the colony. But, with small exceptions, I only encountered a type of degraded mixed deciduous forest (bush or scrub forest, it is true) with which, allowing for differences in species, I was well acquainted in India, where it had never been stigmatized as savannah. On crossing into the Gold Coast from Bonduku to Sampa (or Sikassiko) in the north-west corner of Ashanti, I found large tracts of the same type of forest, to which the appellation of savannah was given. The same nomenclature was found in Nigeria.

The danger of classifying large tracts of a countryside as savannah is fairly obvious. Savannah ordinarily conveys the idea of open grassy areas, or grassy areas with scattered trees of little value and whose rehabilitation would be

costly. This type of country being regarded as more or less worthless waste, little interference with its utilization by the people is usually considered necessary. Such however is not the case, broadly speaking, with much of the so-termed savannah forest in the West African Colonies. It may be still classified as forest, and in many parts, by the simple procedure of closure and fire protection, large areas could be reclaimed; as existing examples of the same type in India in the Central Provinces and Chota Nagpur, where such steps were taken in the last century, well demonstrate.

In the colonies in West Africa the people practise a form of cultivation which is only a modification of the old method termed shifting cultivation. A piece of forest is felled and the material burnt as soon as it is dry enough; the ashes are then spread roughly over the patch, and seed sown with the breaking of the rains. The crop is gathered when ripe, no weeding being undertaken. When weed growth becomes too heavy the shifting cultivator moves on and treats another patch of forest in the same fashion.

This old method, with modifications, is the common form of agriculture in West Africa, weeding being undertaken, and the available forest or bush is in parts becoming inadequate to provide a sufficient yield. Obviously a forest treated in this fashion would gradually degenerate, and with an increasing population the periods elapsing between visits for farming purposes would become shorter, until land hunger, or bush hunger, began to supervene. Some of the last inter-tribal fights which we suppressed were undertaken to acquire fresh bush for cultivation.

This brief explanation has been necessary if the results of the practice of this type of agriculture on the soil, and water supplies, are to be understood in their relation to the Sahara to the north.

If a line is drawn west to east from about Maukono and Grumania in the Ivory Coast through Bonduku—Sampa (Sikassiko) in the Gold Coast—Jebba or Minna in Nigeria, and prolonged eastwards, much of the forest encountered is this so-called savannah; in other words a degraded moist deciduous forest type which is gradually becoming more and more open with the drying up of the water supplies, and will eventually become true savannah and cease being productive to man. This outcome is however more remote here than farther north. In the north the effects of desiccation and the sand danger are in much greater evidence. I will briefly record the observations made in Northern Nigeria and after I crossed the frontier into the French Niger and Sudan.

Kano in Northern Nigeria is well known as an important trade centre in the midst of a rich agricultural tract. Leaving Kano and proceeding due east to Damaturu, and thence north to Geidam, three types of country are seen: first the farmed lands, with scattered baobab (*Adamsonia*) and other species of tree all carefully looked after; the Adamsonia trees are heavily pruned for their leaves. In the dry season it would be easy to mistake this type of country for savannah, with its dried grass areas and scattered scrub. This intensively cultivated country extends some 80 miles east of Kano, and is quoted as an example of the valuable type of agricultural areas existing in Northern Nigeria close to the desert to the north. Secondly there are considerable tracts of a dry degraded mixed deciduous forest of varying quality, subject to firing in the

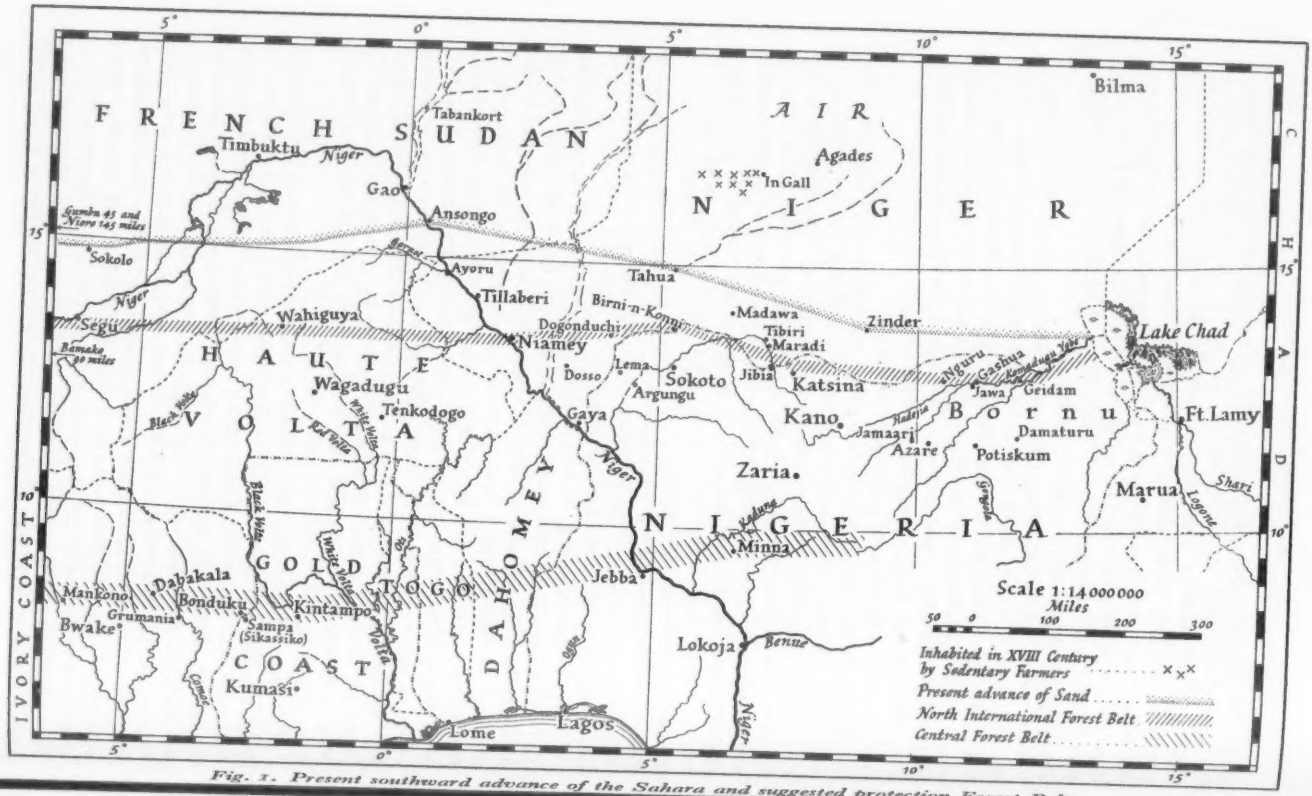


Fig. 1. Present southward advance of the Sahara and suggested protection Forest Belts

dry season by the natives, either for shooting or for grazing. To this type of forest the term savannah has been misapplied. Much of it is capable of being restored to a fair quality high forest. Lastly there are the open more or less sandy areas covered with scattered thorn bush, which are true savannah on the downward grade to pure desert.

For 80 miles east of Kano intensively cultivated lands are passed through. Then come 21 miles of dry zone, low bush or scrub forest with true savannah patches appearing at intervals to Jamaari. Between this place eastwards to Azare, Potiskum, and Damaturu, another 140 miles, the scrub or dry mixed deciduous forest (to give it its rightful name) predominates, interspersed with small farms. The water encountered, with the exception of wells, is found in the shape of longish meres or pools, appearing in unexpected places. I was told that it is held that these are probably the remains of old rivers, now reduced to these patches above ground. The explanation may be correct, since it is obvious that this country must have been formerly covered with a forest belt of a very different type to the scrub areas now existing.

The remains of the Great Bornu Forest, or Old Forest of Bornu, seen between Potiskum and Damaturu and between the latter and Geidam, is witness to the probability of this contention. This forest, open and scattered as it is, covers an area of 90 by 80 miles approximately, and is marked in part at least by the presence of old baobab trees. The population in this region is extraordinarily dense, due to influxes from the north; and some change in the methods of agriculture and the treatment of the remaining forest areas would appear imperative if a further migration to the south is not enforced upon it. Up here the agricultural use of the forest is accompanied by the browsing and grazing of large herds of cattle and flocks of sheep and goats. Here again the numbers of animals are said to have greatly increased during the last two decades. An examination of the forest soil displays a varying depth of pure sand on the surface, the Sahara being only some 60 miles distant from the Kano–Damaturu line.

We came upon a small local industry before reaching Damaturu: iron smelting in its original primitive form, as practised in Europe, *e.g.* Gaul and Britain, in Roman times. The fuel had for long been obtained from the surrounding bush, now become open and dwarf, with much sand present.

Geidam lies 90 miles to the north of Damaturu and under 20 miles from the French Niger Colony and the Sahara; before arriving there real evidence of the desert (sand invasion and true savannah thorn-scrub with the typical Goriba or Dom palm) began to appear. This palm branches like a candelabrum. Here on this frontier of the desert the people are more interested in cattle than in agriculture, a point which had by now become predominant in my investigations.

We called upon the chief of Geidam in the evening at his clay-brick-built palace. Geidam used to be the headquarters of the District Officer and had some troops quartered here. Both have gone farther south, but the village itself has grown into a small town of some importance. It is curious to realize that up in this region the population is actually increasing whilst the means of supporting it are obviously and visibly decreasing. A plot of forest reserved in the grounds of the former District Officer's house and left untouched

Fig. 1. Present southward advance of the Sahara and suggested protection Forest Belts

shows the nature and height of the forest of this countryside 20 years ago.

A river, the Komadugu Yobe, runs due east and west about a mile or so from Geidam, with good duck shooting. An inspection showed that the river at the end of the hot-weather season consisted of a series of large interrupted pools, the major part of the water flowing underground. On going due west to Nguru from Geidam (147 miles) the river is followed closely by the cold-weather road as far as Jawa. In the rainy season it floods all this part of the country, closing the cold-weather road. The interesting thing about the river is that even up here, so close to the desert, it is lined with what is so aptly termed in West Africa, fringing forest; of a good mixed moist deciduous type. The species in this fringing forest are far north of their normal habitat. It is a curious sight to see this beautiful green high forest running as a narrow belt across the country clothing each bank of the river, and to contrast it with the desert-like savannah forest stretching away on either side to the north and south, with the yellow sand of the outer borders of the desert showing here and there as low sand hills away to the north.

Farming is not so important up here. Cattle, sheep, goats, ponies, and donkeys form the chief wealth of the population and the countryside shows it. The true deciduous forest, of a degraded type, is rarer, patches only alternating with the first stages of true savannah of the salt-bush type—much sand and the dom palm appearing in clumps and belts. In some places, if it were not for the dom palm, there would be little else. Yet in spite of the scantiness of the vegetation great herds and flocks were seen and the scrub forest and grass is burnt, great fires crossing the countryside. Overgrazing and hacking in the forest that is left, annual burning, and sand invasion suggest the question: How long before the desert supervenes?

On the subject of this region I wrote the following note on return to Kano: "From what I have seen on this tour from Kano to Geidam and back *via* Nguru, the chief question in this region is the 'Threat of the Sahara.' On the run from Geidam to Nguru we must have seen thousands of head of cattle, sheep, and goats grazing and browsing in the dry mixed deciduous scrub forest or in the smaller areas of a semi-desert savannah; or going down in large droves to drink at the river and the pools or at wells. Owing to the dry season, a proportion of these were owned by nomads and were collected to be near water. But the surrounding forest has to provide the food for them, since they are not stall fed. I also saw much forest burning.

"I have rarely seen such magnificent herds of cattle or finer flocks of sheep and goats, all living and increasing in numbers within 30 miles or on the outskirts of the Sahara. And the desert is advancing! How, or how fast, I have yet to learn when I cross the frontier. It is impossible to travel on the road up to Geidam from Kano, followed by us, or back from Geidam *via* Nguru to Kano, without realizing the serious threat. I have rarely been more impressed with the seriousness of the position than during the last few days. The people are living on the edge, not of a volcano, but of a desert whose power is incalculable and whose silent and almost invisible approach must be difficult to estimate. But the end is obvious: total annihilation of vegetation and the disappearance of man and beast from the overwhelmed locality.

Degraded mixed deciduous forest with fan palms between Dabakala and Bonduku

Savannah between Bamboi Ferry, Black Volta river and Wenchi, N. Ashanti

Savannah between Damaturu and Geidam: recently burnt forest on right, unburnt on left

Dry mixed deciduous forest on the downward grade between Katsina and Jibia

Point reached by the Sahara 3 miles north of Maradi

Savannah forest standing in the encroaching sand between Niamey and Ansongo

"In this connection it must be remembered that populations and their agriculture far to the south of this northern region are also imperilled by the steady invasion of the sand. Has the amount of sand deposited annually, or in 5- or 10-year periods, by the Harmattan on districts in central Nigeria, for instance, ever been ascertained? It should not be beyond the power of man to put up a barrier to this threat; such a barrier as has previously existed."

To the west of Kano in the Katsina division sand-invasion and desiccation has reached a serious stage. The Geological Department have sunk a number of new wells for the use of the agricultural population. Quite recently the Emir of Katsina asked whether some measure of assistance could be afforded him to stem the invasion. Plans have been drawn up to create belts of plantations across the countryside, selected where possible from existing scrub forest or assisting the latter, but taken up in such a way as not to interfere with existing agricultural lands: also to sow seed of the Dom palm along the International Frontier to create a thick belt of the palm. This is a wise step and taken none too soon in the interests of the Province; for poor depreciated scrub forest lands scarcely worth cultivating any longer exist for some 80 miles south from the northern frontier. It is in fact the first stage of the approaching conversion to true savannah.

I was not joining the French Transsaharienne Motor Service till Niamey as the Acting Governor of Nigeria, Mr. Hemmant, had very kindly arranged transport for me from Kano to Niamey *via* Katsina, thereby greatly facilitating my investigations. The Transsaharienne takes two days for the run of 515 miles, Kano to Niamey *via* Katsina, with a night's halt at Birni-n-Konni. I actually started from Katsina; and before leaving there we called upon the Emir, a very popular ruler and great sportsman. The Emir told me he was sending with our party one of his Councillors, who fulfilled what might be described as the part of land agent to him, to act as escort to Niamey. He proved a most intelligent companion and was able to point out the processes of desiccation and deterioration in the land and bush which had taken place during the last twenty to thirty years between Katsina and the frontier, and beyond in French territory.

Katsina is something over 100 miles from Kano, and the new Jibia bridge over the river of that name is some 40 miles to the north of Katsina. On the far side of the bridge (the river was nearly dry at this season) is Jibia village, now increasing in importance as the centre of the important Maradi groundnut trade. A few miles to the north of the village the international boundary is reached and the French Colony of Niger is entered, the frontier town of Maradi being some miles farther on. Here we are on the edge of the desert; for beyond the town low sand dunes, scattered dwarf trees, and a village on the edge of the enveloping sand are met with. The northern road then reaches the large village of Tibiri and here swings to the left, running approximately due west to Niamey.

After turning west we passed for several miles through a piece of semi-evergreen fringing forest, indicating the presence of a river of a character similar to that seen at Geidam; the road, now poor, then took us through interminable miles of the dry deciduous bush, backed eventually by low hills of sand, overlying rock. Large herds of cattle, sheep, and goats were passed

and, after dark, the scrub forest and grass on the low hills was seen burning, the irregular lines of fire creeping up the hillsides: even here—within a few miles of the great desert! The villages passed were Madawa and Birni-n-Konni (The Walled Town) where we halted for the night. There was a sparse cultivation round each.

The same scrub forest continued up to the towns of Dogonduchi and Dosso; but in the vicinity of each there was considerable cultivation and the baobab trees were again present. At Dogonduchi the desert reappears. The town is on the edge of a scarp, and one looked down on to long flat-topped rounded-ended ridges, broken into separate lengths, stretched across the countryside; with, here and there, rounded or bluntly pointed outcrops of dark rock projecting up to 50 feet or so from the sandy plain. To the west of this town, however, good agriculture exists and to a greater extent in the neighbourhood of Dosso which has a resemblance to the environs of Kano. Dogonduchi is about 100 miles from Birni-n-Konni and Dosso 85 miles beyond. For nearly 90 miles after leaving the farmed lands of Dosso we ran through a good type of the dry deciduous forest capable of improvement if the three evils—an improvident system of farming, firing, and over grazing and hacking by the shepherds—were judiciously regulated. Just before reaching Niamey cultivation reappeared, and we obtained our first view of the great bend of the Niger.

From Niamey I was to turn northwards to cross the Sahara. It is of importance to note, however, from the inquiries I made, that the type of degraded scrub forest, varying in quality, continues westwards in the French Sudan on a line roughly through Wahiguya and Segu.

I joined the Transsaharienne at Niamey. We started at 6 a.m. and ran up the eastern bank of the Niger on for the most part a rough track to Ansongo. Throughout a day of heat and unquenchable thirst we were never far from the river. A rocky ridge bounds the western bank, backed by a gleaming yellow sand ridge. On the east, cultivated lands alternated with a fair type of the dry deciduous bush, which became poorer, with much sand present, as we approached Ansongo, reached at 4 p.m. We were now in the French Sudan Colony. The huts of the villages passed are built on piles and looked like collections of gigantic conical beehives. Large herds of cattle, sheep, and goats were seen, the larger proportion belonging to nomads attracted here during the dry season by the presence of water, just as I had noted round Geidam in Nigeria.

Ansongo is a beautiful little town, situated on a bend of the Niger, here expanded into a great lake; the town has a narrow front and stretches backwards into the desert, for the sand and sand dunes have reached Ansongo. In fact a line can be drawn eastwards to Lake Chad showing, historically, the advance of the sand southwards. Sand has invaded the country to the north of Ansongo. The deciduous scrub forest approaches true savannah conditions, *i.e.* dwarf trees or bushes standing in sand, either in small clumps, in irregular lines or patches, alternating with expanses, gradually increasing in size, of a coarse tussocky grass; evidence of the last stage in soil degradation. This is true savannah.

This type, still alternating with areas of dry mixed deciduous forest, which gradually became patches only, continued up to Gao. Beyond Gao and for

some 80 miles on the way to Tabankort, the patches of forest disappeared and various stages of a true savannah were passed, until, about 200 miles out in the Desert from Gao, the last individuals of dwarf trees and the tufted grass disappear.

It is important that the process of what may be termed the extinction of the mixed deciduous forests by man should be understood. By the time this type of degraded forest is no longer capable of providing an agricultural crop, the herds and flocks of the nomadic shepherds have gradually increased or advanced farther south: the two appear nowadays to synchronize. For some time the degraded forest is capable of affording ordinary browsing and pasturage. When however the forest degenerates into open savannah conditions the fodder-producing capacity has decreased. The savannah forest is then treated by the nomad herdsman in a different fashion. Since the animals, by now principally goats, are unable to obtain sufficient sustenance by themselves from the scrub trees, now becoming open and scattered, the nomads treat the area under a rough system of pollarding, the material cut being fed to the goats. The flat-topped broom-shaped trees thus produced are easily recognizable in the last stages of the savannah forest out in the desert. The trees are from 8 to 12 feet in height and under the treatment have developed a dozen or more branches and branchlets arising from a short stem $2\frac{1}{2}$ to 3 feet high, to the point at which the stems are pollarded. Under this system of treatment the final extinction of the savannah forest takes place, when the weakened roots and vanishing rainfall result in the death of the trees.

The above is my reading of the conditions seen in parts of Northern Nigeria, and on the line I passed over in the French Niger and Sudan Colonies. It would appear that, broadly speaking, the tract of country now directly threatened by the desert and in danger of eventually disappearing under the advance of the Sahara is that lying south of some point to the west of Ansongo in the French Sudan and east of this town to Lake Chad; and north of a west-to-east line running from Tenkodogo (Haute Volta), Gaya on the Niger, to Kano in Northern Nigeria and eastwards to Lake Chad.

The historical position of the Southern Sahara, several centuries ago, when the Songhai dynasty ruled, is of considerable interest and importance. Fortunately, owing to the survival of the works of two Arab historians, the position of the countryside and the boundary of the Sahara at the period can be fairly accurately recorded.

The works in question are the 'Tarikh es-Soudan,' by Abderrahman es Sadi, and the 'Tarikh el-Fettach,' by Muhammad Kati.[1] The authors were observant men and themselves took part in some of the history they describe so well. It is however the 'Tarikh el-Fettach' which enables a picture of the Songhai dynasty with its capital at Gao and the regions over which it ruled, fought, and pillaged, to be clearly delineated and depict the Sahara as it was several centuries ago. The second title of this book as given by the translators is

[1] The full titles of these works are: 'Tarikh es-Soudan', par Abderrahman Ben Abdallah Ben 'Amir Es-Sa 'Di. Traduit de l'Arabe par O. Houdas. 'Tarikh el-Fettach fi Akbar el-Bouldan Oua-l-Djouyoûch Oua-Akâbir en-Nas', par Mahmoûd Kati ben el-Hâdj et-Motaouakkel Kâti et l'un de ses petit-fils. Traduit par O. Houdas et M. Delafosse.

'Chronique du chercheur pour servir á l'histoire des villes, des Armées et des principaux personnages du Tekrour.'

The last of the Songhai dynasty (which reigned at Gao from 1335 to 1492) known as Chî was Chî Ali or Sonni Ali or Ali-Ber (*i.e.* Ali the Great) who reigned between about 1465 and 1492; the Chî dynasty was preceded by the Diâ or Zâ dynasty. The twenty-seven years of the reign of Chî Ali were years of terror for his own kingdom and neighbouring tracts. His whole reign was spent at war, his methods being to lay waste the countries conquered on the line of march and raze towns and villages to the ground, massacring the populations, usually with torture.

In this way Chî Ali, as did predecessors and successors, paved the way for the degradation of considerable tracts of what in those days was a fertile country. Chî Ali was succeeded by his son Chî Bâro. The people were however tired of this dynasty of blood, and the latter was defeated by el-Haji Muhammad, who established a new dynasty and united some twenty-four or more tribes in his kingdom. At the time Muhammad was about fifty years of age, and Muhammad Kati, the author of this history, who had been sent by the former as envoy to offer terms to Chî Bâro, was a young man. His chronicle is therefore of all the greater value. Bâro fled to Ayoru, where he lived and died. Ayoru is on the Niger river at the mouth of the Goruol, between Könkiya and Tillaberi.

The kingdom dealt with by Muhammad Kati is termed Songhai throughout the book, whose capital was Gao: the word "Songhai" (according to the translators) was more particularly applied to the eastern portion of the kingdom, that is, the left bank of the Niger from Gao down to the point where the river meets the northern frontier of the present-day French Colony of Dahomey. This then was the additional tract of country over which ruled El-Haji Muhammad, a man celebrated for his justness and wisdom. When he had thoroughly established his sovereignty he determined on making a pilgrimage to Mecca, and it is to the account of this journey by Muhammad Kati that it is possible to state with certainty the nature of this countryside towards the close of the fifteenth century. Muhammad started on his journey on 9 September 1496 and was away till 29 August 1497. He was accompanied by a number of important notabilities, including his eldest son, and chiefs and certain doctors and men of learning, amongst them his wives and women, the chief of the eunuchs and some eight hundred slaves and servants. With this imposing assemblage went large numbers of camels, donkeys, and horses, the line of march, starting from Gao, being through Agades–Bilma–Egyptian Sudan to Mecca.

Without any other record save the one of this pilgrimage it would be evident that at this period this country was a highly fertile and prosperous one with plenty of water. For neither horses nor donkeys can be used for riding and transport unless pasturage and water are available at fairly close intervals; and the fact that Muhammad took his women and a great retinue and was absent for a year indicates that a very different state of affairs existed on the countryside he traversed to that existing at the present day.

Moreover, as late as the eighteenth century all the region to the north of Tahua was occupied by a people living in permanent villages (on the line

Looking up the Niger between Niamey and Ansongo

Ansongo on the Niger

Tussocky grass (last stage of soil degradation) between Gao and Tabankort: savannah forest in the background

Last vestiges of savannah between Tabankort and Bidon Cinq; desert floor of water-worn pebbles and clay

Flat-topped pollarded trees between Tabankort and Bidon Cinq

Tanezruft near Bidon Cinq: no trace of savannah

Gao–In Gali–Agades), the ruins of these villages being still discernible in the sand which has overwhelmed them.

At the present day on a depth (north to south) of 250 kilometres this tract of country is no longer capable of producing agricultural crops, the rainfall being insufficient. In the southern parts a sparse savannah growth affords a precarious existence to the flocks of the nomads, chiefly goats. I am indebted for this information to a French political officer, Monsieur A. de Loppinot, Administrateur en Chef des Colonies, who has had long service in the Niger and French Sudan Colonies and with whom I discussed this subject on our arrival at Colomb Bechar, after crossing the Sahara. It confirmed my own observations. From his personal observations and inquiries he says that in this

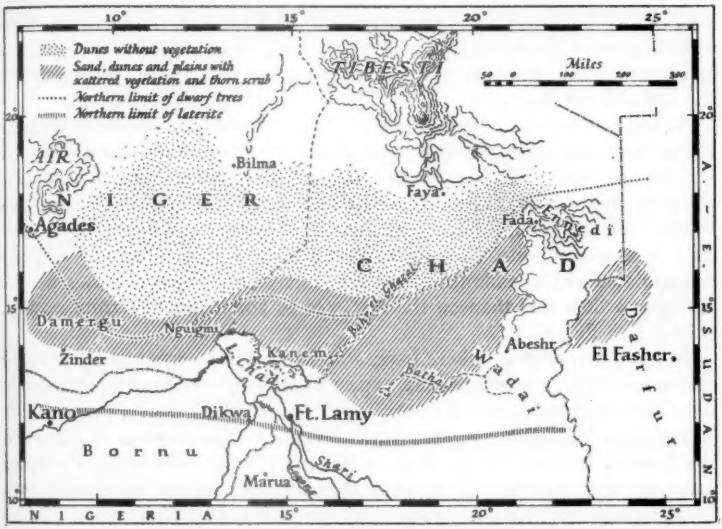


Fig. 2. Sketch by Lieut. Eon showing advance of the Sahara to the line Zinder–Lake Chad–El Fasher

region the Sahara has advanced at an average rate of 1 kilometre a year during the past three centuries.

Lieutenant Eon, of the French Senegal Regiment, who has spent some years to the north of Lake Chad, also furnished me with some interesting information on the subject of the advance of the desert southwards. From the plan he was kind enough to draw for me it will be apparent that the line of advance of the sand in this region is from West to East Zinder–Lake Chad–just north of Abeshr, continuing in the direction of El Fasher (in Darfur). North of this line there exists a region of sand with the open savannah gradually disappearing. The limit of tree vegetation of all types is shown by the dotted line in the plan, starting from Agades on the west and, with loops to the south, ending at Fada on the east. This in fact corresponds with my Ansongo–Lake Chad line to the west. North again there are large regions of sand bare of all

vegetation, which formerly were agricultural lands and subsequently grazing lands of the nomads (see Fig. 2).

The explanation of these two areas Lieutenant Eon gives as follows: To the north there are two large hilly and mountainous areas, Faya on the north-west, south of Tibesti; the other on the north-east, Ennedi (1500 metres). Between these two, sand from the Sahara has blown through in increasing amounts covering up the land and forming the eastern of the two sandy regions on which no vegetation is now found. The second or larger sandy region, according to the map, is situated to the west. This is due to sand which has come in from the mountainous region of Air (1700 metres) and Bilma.

The significance of these observations lies in the fact that the great tract of country to the north of the line Zinder–Lake Chad (which forms the north-east corner boundary of Nigeria)–Abeshr–El Fasher is now a sandy waste affording scanty pasturage, in reality browsing only, in the ever-decreasing tracts where the remnants of the savannah scrub still persist immediately to the north of the line.

As regards the region to the west of this portion of the course of the great Niger river, the senior French political officer aforementioned told me that the state of affairs existing on the Gao–In Gall–Agades line also applied in the west. He stated "The same remark may be applied to all the Sahara zone of the French Sudan, formerly inhabited by permanent villages to the north of a west-to-east line through Yelimane–Nioro–Gumbu–Sokolo and now unpopulated and abandoned: here the tract of country which has become desert is a little less than on the east, 150 to 200 kilometres from north to south" (see Fig. 1).

In Northern Nigeria, where I was able to observe a certain area for myself and to form my own conclusions, expert forestry opinion was represented by Mr. Weir, Conservator of Forests, who has served for over a decade in the region, and Mr. Brand, a more junior officer and Conservator of Forests in the Katsina Province. I met both in Nigeria and have discussed the matter since, for they were both on leave in 1934 after my return. In forwarding to me the rough map I had suggested their preparing, Mr. Weir wrote: "I think that at present it can be truly said that except for isolated patches of 'waste' land, the stage of being put out of cultivation on a large scale by sand drift, though in many cases near and only requiring a drought or so, is not yet general in these Northern Territories. One example of the type of practice which has resulted in assisting the advance of the Sahara southwards in present times may be quoted. The intention was excellent but ill-advised. The Lema Forest Reserve in the Argungu Division of Sokoto is shown due west on the sketch-plan. This forest consists of dry zone degraded deciduous species (Baobab, Anogeissus, Acacia, etc.). Some three years ago there was a threat of famine due to locusts. The people residing in the enclaves in the forest, including some who had no business to be there, appealed for a new area for 'farms' on the plea that their old land was either unsuitable for farming or worn out. The place is some distance from Sokoto and inaccessible except to slow transport. The people were allowed to fell some 600 acres or so of forest, an area far larger than their needs, with the idea of taking advantage of the high prices the famine would bring about. As it happened the locust menace did not super-

vene and consequently no famine arose. Much of the disafforested land was not cultivated and has since become a complete waste of drifting sandy soil now incapable of cultivation, and on which a first attempt to reafforest by the Forest Department has failed, owing to the desert conditions becoming so rapidly established" (see Fig. 3).

From my own observations on the ground, backed by a considerable study of this particular danger in other countries, many examples could be added. Space and time limit me to the above; opinions of officers of two different nationalities, living in close conjunction with the Encroaching Sahara.

From these observations it would appear, then, that the Sahara has reached a line running east from Ansongo in the Niger and that to all intents and pur-

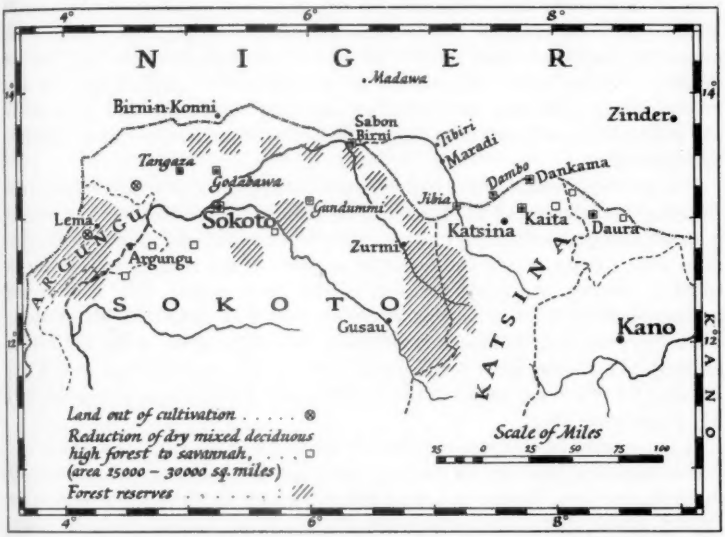


Fig. 3. Reduction of deciduous forest to savannah type on N.W. frontier of Nigeria

poses it has attained such southern outposts as Tibiri Village, north of Maradi, and Dogonduchi, both in the French Niger Colony: the frontier lands of Katsina territory and Geidam in Northern Nigeria. In other words, the tract of country now directly threatened by the Sahara, over which the next big stride forward will, things continuing as they are, be made, is that contained by a west-to-east line through Ansongo, on the north; and a west-to-east line through Sokoto–Katsina–Kano and eastwards, on the south.

An investigation as important as that now under consideration requires to be followed by some suggestions of a practical nature. For the northern regions we require to know: (i) What is the present position of sand invasion? (ii) Are there any figures showing what the invasion amounts to every year? (iii) What has been the amount of sand deposited on the surface of the land per year or per ten-year period for the last two or three decades? (iv) How

does the sand-drift affect the returns from crops? What decrease in values has there been during the last two to three decades? (v) What effect has the sand-drift and consequent desiccation had on water supplies? Was the necessity of sinking the new wells in the Katsina Division due to sand-drift and desiccation?

The large amount of so-called "savannah" forest in the West African Colonies is due to the existing practices of "farming" the forest lands (*i.e.* shifting cultivation) and to burning the forest areas annually either for shooting purposes or grazing flocks and herds. In the central portions of the Colonies, Nigeria, Gold Coast, Ivory Coast, large tracts of this forest are becoming yearly more degraded. It would be interesting to know for each district: (i) The area of land under farms annually. (ii) Is there any rotation of the farmed lands? (iii) What increase in the farmed lands at the expense of the bush savannah (degraded mixed deciduous forest) has there been during the last decade? (iv) Are there any records on the subject of depreciation of soil values, falling off in crop returns and drying up of water supplies? (v) Is there any ruling in force by which the annual burning of the forests can be stopped or regulated?

It is not the purpose of this paper to deal with possible practical measures of stopping the advance of the Encroaching Sahara. Since however the matter is one affecting two of the big Powers of the world to-day, the following suggestions will, I hope, secure the powerful support of the Society in making an effort to counter the silent invasion of this great desert. The shelter-belt scheme outlined for the Katsina Province, which is under consideration, is correct in principle. But isolated efforts to stop the progress of the Sahara are unlikely to stem the invasion. A much wider policy is required. Is this not a matter for which a grant from the Development Fund might be considered? My suggestions are:

I. To reserve an international belt to the north in the degraded dry mixed deciduous forest bounded on the south by a line across Haute Volta, eastwards through Northern Nigeria to Lake Chad and on the north by a line across the French Sudan eastwards through the French Niger Colony to Lake Chad: that is, a belt on both sides of the frontier as continuous as may be found possible and of such a depth as may be determined by the two nations, but not less than $7\frac{1}{2}$ miles on either side of a line running eastwards from Niamey through Birnin-Konni, Katsina, Nguru, Geidam to Lake Chad; and westwards from Niamey through Wahiguya and Segu; a front of some 750+620 or 1370 miles.

Owing to the existing population, pressure on the cultivated lands in parts, and the numbers of cattle, sheep, and goats in this northern region, the breadth of this belt would depend on several factors. The most important is a recognition by the officials on both sides of the frontier of the actual position which exists *vis-a-vis* the desert, its capabilities on the one side, and the present acts and habits of the populations residing on its southern borders on the other. Proof of the steady advance of the Sahara exists. The practical question appears to be: Are there any means which may be or can be devised to check the advance? If a forest belt is the answer: in other words, to reproduce what previously existed and effectively checked the southward advance, then

that belt must be on a scale sufficient to deal with the force opposed to man. Piecemeal efforts will certainly not meet this silent invasion.

II. To reserve a broad belt of the degraded moist mixed deciduous Forest (so-called savannah) as a Central Protective Belt of, say, some 30–50 miles in depth, roughly to north and south of a line running eastwards from Dabakala and Bonduku (Ivory Coast), Kintampo (Gold Coast), and Jebba or Minna (Nigeria), and eastwards; and westwards from Bonduku through Mankono, etc.

The suggestions for the above belts had been made a couple of months before the announcement of the projected 1000-mile reafforestation belt in the United States. This latter scheme was stated in the Press to be "the most ambitious reafforestation project ever undertaken for the modification of climatic conditions (*i.e.* growing tendency to chronic drought) threatening the existence of many agricultural countries in the Middle West."

In my belief the threat of the encroaching Sahara can be largely met by conserving and improving existing degraded forest; and the urgency is even greater than in the Middle West of the United States. The Central Belt has much the same purpose as the proposed Middle West one—though the farming systems are different. But the northern belt is required to counter one of the most silent menaces of the world, if not the most silent one, the imperceptible invasion of sand.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: Our lecturer to-night is Professor E. P. Stebbing, now Professor of Forestry in the University of Edinburgh. Professor Stebbing has been known to me by repute for many years. He was originally in the Indian Forest Service, and I know him best by what he has written during his career in that service as a sportsman-naturalist, in which capacity he wrote two or three interesting books on sport and natural history. More recently he has made a particular study, in the course of travels in West Africa, of the great question of the encroachment of the Sahara. It is a subject of vital importance. There are so many aspects of it, *e.g.* what is the cause of the encroachment? What is its effect on the various elements of Nature? How can it be dealt with in the present case in order to prevent it swallowing up country to the south, as it appears to be gradually doing? Professor Stebbing will now give us an account of his exploratory travel there, from the point of view of a forest expert, and he will advance his views as to how the danger can be mitigated. I hope we shall have an interesting debate after the lecture as we have several forestry experts with us who will be interested to hear Professor Stebbing's views and theories. I will now ask him to read his paper.

Professor Stebbing then read the paper printed above, and a discussion followed.

The PRESIDENT: Mr. George Hemmant, whom the lecturer referred to as having been Acting Governor of Nigeria during the period November 1930 to June 1931, in which Professor Stebbing visited the country, is with us and I ask him to say a few words regarding the Professor's tour and work from his point of view as chief Government official.

Mr. G. HEMMANT: The President has very kindly given me the opportunity to express our thanks to Professor Stebbing for his extremely interesting lecture. I think I have been given this opportunity because I happened to be the Acting

Governor of Nigeria when Professor Stebbing visited that country. He came to us after a most exhausting inspection of the forests of the Ivory Coast, and it is some indication of his astounding enthusiasm and energy that he announced his intention, after being one night with me, of journeying home *via* the Sahara. I presume it was on that journey that he produced those wonderful photographs which you have just seen. I did my best to assist Professor Stebbing in a small way and provided him with transport in the form of a car, which he informs me broke down and threw him into a ditch. However, that does not seem to have embittered him.

There are too many experts present this evening for me to express any opinion on the technical aspects of this question, but I think that all who have spent any time in the tropics, though they may not know anything about the Sahara and the effect on the actual rainfall of destroying forests, do know that the destruction of forests has a great effect on the value of the rainfall. The difference between rainfall on a forest area and rainfall on a cleared area is astounding: the run-off of the water from a cleared area is so rapid. I was able to see something of this in Malaya during the early days of the rubber plantation industry when it was the fashion to clean-weed the estates. The effect was that whereas on a large area of jungle an inch of rain would keep streams alive for two or three weeks, the same area when cleared and cleaned would probably be dry within twenty-four hours. In Malay this mattered less because the planters themselves suffered by losing their soil, and therefore took measures to put things right by means of catch crops and silt-pits. But a country with native peasants is not so fortunate. They have not the intelligence to protect themselves or their country. I think that this aspect of the question will appeal to all who have spent any considerable time in the tropics.

The PRESIDENT: Major Oliphant, would you make some comments? Major Oliphant was the director of the Forest Products Research Laboratory, and is now adviser to the Colonial Office on the development of Colonial forest resources.

Major F. M. OLIPHANT: I should like to support most strongly what Professor Stebbing has said to-night about the danger from the southward encroachment of the Sahara. There is no doubt whatever that the danger is acute, encouraged as it is by the creation of small, internal saharas by burning, uncontrolled cutting and grazing, and shifting cultivation. The most serious difficulty is that, in spite of all the local evidence of deterioration within the length of a man's service, and in spite of all the evidence from almost every part of the world of the evils that follow upon forest destruction—in spite of all this, it is for some reason an extraordinarily difficult thing to spread conviction that this danger does exist and, still more, that it is acute. This may be partly because there is a tendency to look upon the forester, or any other specialist for that matter, as a man of one idea, and to discount his opinions as probably exaggerated. If this Society, as an independent body, can find some means of exploring the situation, checking the statements of the specialist (including mine!), and conveying conviction of the need for action, it would be an invaluable achievement. There seems little room for doubt that, at no distant date, some of the colonial administrations will be faced with the very difficult problem of emigrating population from districts no longer able to support them. Where are these people to be moved? What is to happen to the Emirs of the states so moved? There is already warning of such a prospect, as mentioned by Professor Stebbing, in the considerable immigration of men and domestic animals that is now taking place from the north of the international border southward into Nigeria. The reason of this migration was given me in the popular phrase "pax Britannica." It is much more

likely that the people have been driven south by the decreasing means of subsistence northward.

Professor Stebbing has mentioned that some action has been taken to combat the danger in the Katsina division of Kano Province. The point is that this action was due rather to local apprehensions than to any general realization of the danger, except, of course, on the part of the Forest Service. The scheme is 9 miles in depth and 60 miles in length. Its right flank is based on Daura. South and a little east of Daura, *i.e.* almost outside the protective screen, is the very important market town of Kano mentioned by Professor Stebbing, 60 miles from the frontier. As the Professor says, the neighbourhood is thickly populated and very closely farmed. The Katsina barrier is probably not long enough to protect Kano, and both Katsina and Kano could be outflanked, I should think, if the scheme is not extended. It is hoped to do this, but so far as I am aware there are no present signs of the hope being realized. The existing forestry staff is very meagre for the size and needs of the country, and, like other colonies, Nigeria is passing through financial difficulties owing to continued depression in the prices of her primary commodities. One must wonder at the same time whether the urgency of the situation under review has been considered at its true value in relation to other needs. As to the rapidity of deterioration in the Katsina division, I was informed that thirty-five years ago big game existed around the border village of Dunkama, the mid-way point of the screen: the present game consists of rabbits and rats !

Regarding the lack of appreciation of this problem, and the general one of climatic deterioration, the Gold Coast Handbook is rather illuminating. In the south and centre of that country there are large areas of plain and scrub country, and areas where the rain forest has given way to the drier monsoon or mixed deciduous type, much of this change being due to shifting cultivation. This kind of country extends more or less to the range of hills that starts 20 miles north of Accra in the east and runs north-westward, generally parallel to the coast. Of these hills the Handbook says: "They appear to form a barrier against the advance of the scrub and plain country from the south." Nothing about the reasons for the advance of these drier conditions, and nothing about a similar danger from the north. When I was there in 1932 the forests of the hills were by no means fully protected along their whole length. I went north of them as far as Ejura, 50 miles north of Kumasi. This is beyond the region of the Mampong scarp, the watershed between important rivers of the south and the Afram river on the north. The increasing degradation of the country is obvious, even there. Lacking proper protection of these hill forests, there seems no reason why the drier conditions south and north should not meet and overwhelm the fertile valleys beneath the southern line of the hills.

Again, the Handbook speaks of "an inexhaustible supply of timber." The fact is that they have been cutting down the forests in the process of shifting cultivation at the rate of 290 square miles a year. I do not personally think that there is now sufficient timber to support an export trade of any considerable magnitude, in addition to the country's domestic needs. About 1908 Mr. H. M. Thompson made a survey of the country, for forestry purposes. His map of that date compared with a map of to-day not only shows a great diminution of timber supplies but also the considerable loss in fertility that has taken place, for a very large area marked by him as rain forest is now replaced by the drier, mixed deciduous forest. But an even more alarming situation than the decrease in timber supplies, in connection with the Gold Coast, is the danger to cocoa cultivation. The Gold Coast's revenue comes mostly from cocoa, which is responsible for about five million of their seven million pounds' worth of trade. Cocoa needs a moist atmosphere and a moist soil, and forest-destruction is

letting in the drying winds and allowing increased evaporation from sun and wind, so that conditions are in danger of becoming altogether too dry for cocoa-farming. Fortunately the administration is now tackling the problem, though at this very late date. But I give it as a good illustration of the great lack of foresight that has existed in this matter. If a situation at the front door is not realized, it is still less likely that the problem in the northern territories, remote from the seats of government, will be realized.

The PRESIDENT: Professor Troup has been Professor of Forestry at Oxford since 1920 and Director of the Imperial Forestry Institute since 1924. Also, like Professor Stebbing, he was formerly of the Indian Forest Service. We should like him to address us.

Professor R. S. TROUP: Professor Stebbing has drawn attention to a crying need in West Africa, and not only in West Africa, for the same need exists throughout the Sudan tract stretching right across to the northern borders of Uganda, where there is also some danger of desiccation through destruction of forests.

As a forester I feel I have to be somewhat guarded in accepting statements without very definite proof: statements, that is, as to the effect of the destruction of forest. I think most of you know that the so-called desiccation of Africa is attributed in large measure to climatic causes, to some climatic cycle which is on its way towards drier conditions. That may be true, but I think that in the case of the encroachment of the Sahara we have definite proof within historical times that the encroachment of sand is due in part to the destruction of forest. I read recently—though with what truth the statement was made I do not know—that in certain tribes in Northern Nigeria the women were refusing to bear children because of the fear that the next generation would starve; and that the migration southward, which is known to be taking place, is due to the encroachment of sand from the north.

Now it is a well-known fact that when any obstacle is placed in the path of shifting sand it can form an effective barrier to its further spread. We know that from our experience of similar sand movement along coastal regions: for example, along the coast of the Bay of Biscay in France, and on a smaller scale in the case of some of our own coastal districts. We know that by afforestation we can prevent the inroads of shifting sands from the sea coast. On that basis a broad belt of forest maintained in the path of shifting sand ought to do a great deal of good. In the absence of any personal knowledge of the country I did not exactly grasp the reason for the two long belts of forest as shown in Professor Stebbing's map, but I have no doubt the positions have been selected with some eye to the result.

There is one matter in which I am unable to follow Professor Stebbing, and that is in his definition of savannah forest. He objects to the use of that term for the particular type of degraded mixed deciduous forest which he showed in those excellent slides of his. Judging from descriptions of savannah forest given by the leading authorities of the last few decades, including Schimper and Warming, the forest which Professor Stebbing described as mixed deciduous forest is definitely savannah forest. One can tell that from the presence of the rank growth of grass in the undergrowth. And what is more, the term "savannah forest" does not, as I think Professor Stebbing implied, mean that the forest is necessarily of a worthless type. For example, the valuable *sál* forests of India are savannah forests; so are many of the eucalyptus forests of Australia, while the pine forests of British Honduras and many other valuable types of forest are definitely savannah forest because of the growth of grass; and when a savannah forest is destroyed it reverts into grassland. That is the distinguishing feature. The degraded mixed deciduous forests of West Africa Professor

Stebbing likens to the mixed deciduous forests of Chota Nagpur in India. But these latter are also classified by Warming as savannah forest.

This question of definition may be only a technical matter and one of comparatively small importance, but I feel that by using the term "savannah forest" we must not go away with the idea that that particular type is worthless. It is merely a convenient term to denote a large variety of types of forest, with one main distinguishing feature, namely, an undergrowth of savannah grass.

I am sure we have derived a great deal of benefit from Professor Stebbing's most interesting lecture, and I should like to join with the other speakers in expressing my great pleasure at having listened to it.

The PRESIDENT: Sir Arthur Hill, would you add a word or two? Sir Arthur Hill is the Director of the Royal Gardens, Kew.

Sir ARTHUR HILL: I think, if I may say so, we have been considering the Sahara rather from the wrong point of view. All the stress has been laid on "the encroachment" of the Sahara, but I would rather like to put it that the Sahara has seized the opportunity of man's stupidity. The troubles from which the West African colonies are suffering, as Professor Stebbing, Professor Troup, and others have pointed out, are due mainly to the way in which man, and especially the native of West Africa, has cut down, burned and, with the help of goats, etc., destroyed his forest.

I am very much in sympathy with some of the proposals made by Professor Stebbing, but I have some doubt as to the practicability of the measures he proposes. For instance, in the Gold Coast it would, I believe, be necessary to have all the laws with regard to land tenure altered, and one knows for how long a time an attempt has been made by the Forestry Department to get some control over the forest, but with very little success. What would happen if we tried to reserve or to plant a belt of trees in the northern areas and keep out goats and men, I am not quite sure.

I took the trouble, as Professor Stebbing has given the figures of the length and breadth of his belt, to see what would be required in the way of actual numbers of trees, and I am not citing the result in any disparaging way but merely to show what the proposition really means. The belt proposed is, I understand, to be 15 miles broad and 1370 miles long. If trees were planted at 6 feet apart, which would be the sort of thickness necessary, there would have to be 15,914,000,000 trees on that belt. I cite those figures to show the magnitude of the proposition. I am not sure whether Professor Stebbing intends this belt should be planted, but in certain parts this would certainly have to be done. In any case the reservation of such a belt and the exclusion of goats, man, and browsing animals, would be a very formidable undertaking. Who would undertake the necessary planting of the belt, and who would maintain it when planted, and ensure its proper reservation? No doubt such a belt would serve a most useful purpose, but many problems would have to be faced and overcome before the proposition could be put into effect.

The PRESIDENT: The hour is late, and I do not think we can continue this interesting debate; I will accordingly ask Professor Stebbing if he would like to make any observations in reply.

Professor STEBBING: I should like, if I may, to make the briefest of replies to the remarks made on the paper. I was most interested in Mr. Hemmant's expression of opinions and I am sure that those who know him regret that we have lost such a good Governor. And, may I add, one who has so clear an appreciation of the effects of excessive forest destruction and the improvident habits of a native population on a tropical countryside.

I welcome Major Oliphant's remarks. The question of the migration south-

wards of the population on the southern borders of the Sahara is likely to become an increasingly difficult problem; as also the idea that the forest in any particular region is inexhaustible, whether high forest or so-called savannah; if the present treatment accorded to it in West Africa is persisted in without the introduction of some essential restrictions. When we started work in India the same idea was prevalent: that the forests covering untold thousands of square miles of countryside were inexhaustible. As years went on it was gradually realized that this was not so. At the present day those who have given any study to the question are aware that no forest is inexhaustible.

The same type of development, described by Major Oliphant for the Gold Coast, is starting on the grand scale in the rich Ivory Coast Colony. I had the opportunity and pleasure of discussing this question of plantation, development, and the effects of forest clearance with the able Governor, M. Reste. As regards Professor Troup's remarks on savannah forest, I, of course, accept them unreservedly from the point of view of the forest botanist, and his minute classification of various types of forest. I accept them, even, from the sylvicultural research-officer's viewpoint, if they are likely to assist the executive forest officer in his sylvicultural work. But to the ordinary man, the average District Officer, and the ordinary practical forest officer with no special leaning either to forest botany or sylvicultural research, the term savannah forest usually implies a grassy, open, scrub-covered area, or a grassy area with scattered trees dispersed over it; in N. Nigeria, Haute Volta, French Niger, and Soudan, sand replaces the grass. When I first went to India and spent three years in Chota Nagpur with a similar type of forest in parts, I never heard the term "savannah" applied to it. Whilst in the Ivory Coast, on the borders of the so-called "savane" forest country, in discussing forestry matters with a senior experienced Administrateur (District Officer), I inquired as to the nature of some forest over to the north. "Oh! that is worthless," was the reply, "it is only savane." I subsequently found it to be a degraded form of mixed deciduous forest of the type I had been acquainted with in parts of India and quite capable of improvement by closure and protection.

With reference to Sir Arthur Hill's suggestion that some sixteen thousand million trees would be required to plant my suggested northern forest or shelter-belt against the Sahara, I regret that I did not make myself clear upon the point. In considering all questions of forest reservation in West Africa we may start from the basis that the whole country is covered with forest, the greater part being the so-called savannah; the system of cultivation being dependant upon the presence of this forest cover on the land. My suggested northern belt, 15 miles in depth and 1370 in length, would be constituted, allowing for necessary breaks making a passage from north to south, and vice versa, etc., out of existing degraded forest by the enforcement of closure and protection from farming, fire, and grazing. Such plantings as might be required, after the type of the present Katsina operations, would be a matter for later consideration. The greater part of the belt, as in the case of the proposed central belt, could be brought into being at a minimum cost and certainly without the incidence of heavy expense on artificial afforestation operations. The actual line of the northern belt would have to be laid down by a small Franco-British Commission.

The PRESIDENT: I think we have had brought home to us an extraordinarily interesting problem in regard to which a vast amount of information and understanding is required, as indicated by the aspects of it which have been discussed. I offer my cordial thanks to the distinguished forest scientists who have been good enough to come and join in the interesting discussion and again thank Professor Stebbing for giving us a lecture which has raised a great amount of interest among us all. Professor Stebbing, we thank you very much indeed.

THE SALAR MUHAMMADANS

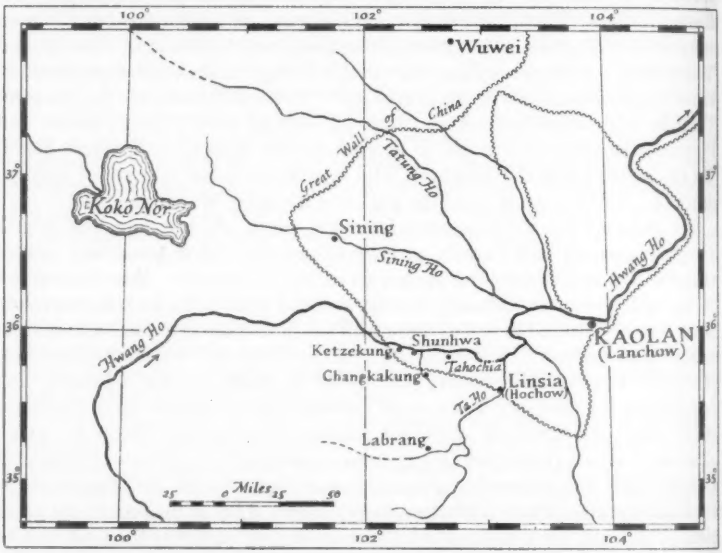
ABBOT LOW MOFFAT

FAR up in China's great north-west, in the Province of Kansu, the Hwang Ho River passes through a little-known spur of the Great Wall of China which, running almost north and south, marks a former Chinese–Tibetan border. A mile or two below the wall there rises, on the north bank, a great cliff that flames vermilion in the winter sunset. To the north live a simple Lamaistic people of Mongol origin whom the Chinese call the aborigines. They speak a Mongol dialect and the women wear a curious dress with overlapping aprons. To the north-east dwell the Chinese—red-cheeked, strapping, 6-foot Kansu natives. Then, farther towards the east, are Muhammadan Chinese, converted at the point of the sword during the great rebellion of the 'sixties; and Tung Hsiang Muhammadans, who speak a Mongol dialect and are apparently kin of the aborigines converted in ages past. To the south-east are the powerful T'ashih Muhammadans—Arab Moslems—among whom many Semitic and Persian countenances are still to be seen despite infusion of Chinese blood. To the south dwell the Tibetans, who in this particular area are of Mongol descent. To the west, beyond the wall, live the Salar Muhammadans.

We entered the Salar country from the south. At Labrang, the largest Tibetan lamasery in the north, we encountered two Salars homeward bound, who for the sum of fifty-five cents agreed to act as guides. We climbed out of the valley wherein Labrang is situated into a great rolling basin of treeless grass country, dotted here and there with yak and sheep and alive with rabbits and ground sparrows. A few worn terraces were the only reminders that once, centuries before, this country had been occupied by the Chinese. Our destination for the night was a small lamasery on the farther lip of the basin at the base of a towering limestone palisade. In the clear winter air, at an altitude of about 11,000 feet, it appeared a pistol-shot away, but it was not till a chilly dusk was descending that our horses mounted the last steep slope to Djakkar Gomba (White Cliffs Lamasery), where it lay at the foot of the great cliff. The usual route across the hills lay some 5 or 6 miles to the west, and to save the extra miles of travel our Salar friends obtained the services of a Tibetan peasant to guide us by a shorter route. We started very early in the morning. The stars were enormous. We descended some 500 feet, forded a small stream, and began to clamber up a delta-like formation below a gap in the palisade. The trail was very steep and more than three hours passed before we reached the divide where numerous valleys and higher hills were to be seen, but no individual mountain or peak of any size.

Very little snow falls in this country and none lies on the southern slopes. On the northern slope however which we now had to descend perhaps 2 inches of snow nestled deep among the blades of grass except where, more exposed to the sun, it had at some time melted and turned to dangerously slippery ice. The descent was far steeper than the ascent, and we slithered down many hundred feet before we reached a small brook along which we had a clearly defined trail and easier travelling. The snow was soon left behind. All afternoon we followed the brook which soon became a fair-sized stream. At

places the banks became too steep for the trail to follow the edge of the water and laboriously we climbed over some projecting spur. Not until an hour or two before sundown did our trail join the main horse-route over the hills and our Tibetan guide depart on his return journey. Still another two or three hours elapsed before we reached the most southerly Salar settlement, Naimankung. Our two Salar guides led us to a small inn and then went their own way, but with them vanished the innkeeper. In Tibet our Chinese boys had swaggered considerably, pretending they were Muhammadans, for the Muhammadans had recently defeated the Tibetans in several battles and were held in considerable fear. Here however they were in a Muhammadan community, always unfriendly to the Chinese, and among the Salars, who above all other Muhammadans have the greatest reputation for hostility and fanatical



Part of the Province of Kansu visited by the author

ruthlessness. We were all cold and tired and our boys were very hungry too, having refused to adapt themselves to Tibetan food. The disappearance of the innkeeper, leaving the rooms black and frigid, added to their nervous moroseness. But our host finally returned and having overcome his first suspicions proved very friendly, and when at last a piping hot and much-appreciated meal was ready even our boys cheered up. We fell asleep that night tired but content with the world, and dreamily convinced that Naimankung was one of the really choice spots of the earth.

The next day we rose late. It was the coldest day we had had, but one of those still, clear, sparklingly cold days on which one rejoices to be alive. I wandered out in the courtyard while breakfast was being prepared. The little valley in which Naimankung lies runs north and south between high hills, and the sun had not yet reached the valley bottom but was flooding the

The mosque at Ketzekung

Field of the White Camel Stone at Ketzekung

Salar children at Naimankung studying the Koran

A Salar school in the mosque at Naimankung

western slopes. In the shadow of the hill the cold seemed intense. A little daughter of the innkeeper was scampering about the yard carrying her baby sister on her back. As the first rays of the sun reached the yard the mother appeared in the door and called for the baby whom she began to dress. Up to that moment the baby had apparently been quite happy without a stitch of clothing. It is astounding how much cold the children in the north-west can stand. It is very common to see young boys and girls clad only in hats with warm ear tabs and short jackets reaching barely to the waist. Small ponds will sometimes be crowded with half naked youngsters sliding on the ice or sitting while some friend pulls them about.

After a leisurely breakfast we strolled out into the smiling valley to visit the tomb of a local saint. A throng of children and some of the grown-up villagers accompanied us. The tomb, one of the loveliest I saw in China, was a single-chambered octagonal building of grey brick, set charmingly among trees in a small garden. There was delicate and beautiful carving around the door and on each wall. The interior was panelled in light-coloured wood, and again the hand of a master craftsman was evident in the charming carvings of birds and other animals that decorated each side. The coffin, itself of similar wood, stood in the centre of the room and was plain except for a small ornament at each end. We returned to the inn, mounted our horses, and started down the valley. Presently we came to a mosque. On the sunny side of one of the court-yards school was in progress—sixteen little youngsters squatting in a row, reading the Koran at the top of their lusty voices. The *ahung* (a Persian word for teacher, which is applied by the Chinese Moslems to one who can read the Koran) stood behind them supervising. The recitation stopped suddenly at our entrance. As to all schoolboys, an interruption proved entrancing. We were the first white men they had ever seen. Indeed with the exception of two missionaries who had passed rapidly through a few months before, we were, so far as I have been able to ascertain, the first white persons ever to enter the Salar country, and the photographs which I took are the first ever taken there.[1] Even the *ahung* was greatly interested and his warm hospitality became cordiality itself when he found that my friend not only conversed in fluent Chinese but read and spoke Arabic. The prefect of the school, a bright-eyed lad of ten, mustered the boys in line and we were invited into the guest chamber, a small square chamber containing several scrolls and a cheap lithograph or two of Mecca and Medina. On our departure the old *ahung* pressed us most warmly to pay another visit whenever possible.

Beyond the mosque the valley began to widen and before long we were able, from a slight rise, to look over the flat roofs of Changkakung, one of the largest Salar towns. Near here the route from Hochow, the usual approach to

[1] *The only previous travellers on Mr. Moffat's route from Labrang to Shunhwa seem to have been Potanin, who visited the Salars in* 1882*; Rockhill, who in* 1892 *travelled along the Hwang-ho and gave an account of the Salars in his 'Diary of a Journey in Mongolia and Tibet'; Tafel, who was in the district in* 1905 *and speaks of the Salars in 'Meine Tibetreise'; and finally Kozlov in* 1909*, who however gives no details of his route in his article published in this Journal, vol.* 36*, p.* 298*. It will be seen that Mr. Moffat and his companion were not actually the first white men to visit the Salars, though no other Europeans have left such a detailed account either of the country or its inhabitants.*—ED. *G.J.*

the Salar country, joined the road we were following, entering through a valley from the south-east. The stream had now grown to very considerable proportions. The hills on either side were deeply eroded. The higher ones were capped with yellow earth, resting on horizontal beds of a soil which in certain lights ran from vivid vermilion through various shades of red, blood, and even plum colour. A few miles ahead of us the hills on the northern bank of the Hwang Ho River rise steeply at right angles to the valley we were descending, curiously banded in lilac and green. The road had for several miles followed the east bank of the stream, but about a mile above its confluence with the Hwang Ho River a new and excellent bridge carried us across, and after traversing several natural terraces we found ourselves in Shunhwa Valley. The valley is a beautiful one, several miles in length and more than a mile in width. At the lower end on the southern side broad steps of rock are exposed and the road winds over these before moving out on the level valley floor through the centre of which the Hwang Ho River, here deep green (December), flows in a trench-like cut. In places the valley is benched and terraced, the upper benches composed almost entirely of river-worn stones.

It had been noticeable that as we descended the stream from Naimankung to Shunhwa Valley the mosques were so close together that one was never beyond the call of the muezzin. But now in Shunhwa Valley no settlement was to be seen save the walls of Shunhwa itself, rising gaunt and lonely some distance back from the southern bank of the river. It is a typical Chinese town, the seat of a Chinese magistrate, and no Salar dwells within its walls. In 1894 a bitter dispute arose between the Salars who belong to the New Sect and their T'ashih co-religionists, most of whom are Old Sect. The dispute involved an interesting point of doctrine: at what age was it proper to grow one's beard. Feeling ran so high that eventually fighting began, and the Chinese interfered. The governor, thinking to stop the trouble at its source, crucified the leading Salar, nailing him to the city gate. But the result was the very opposite of what he had hoped. The Muhammadans sank their differences in their common frenzy against the Chinese, and for two years rebellion, slaughter, and famine raged through Kansu Province. Tens of thousands of men, women, and children were put to death by one side or the other. Whole towns were destroyed. In the end the Muhammadans had to yield. The Salars defending Shunhwa were betrayed by the leader of the T'ashih Moslems and slaughtered. Among other conditions imposed by the Chinese all Muhammadans were forbidden to live within city walls, but as no prohibition was placed on the suburbs within their auxiliary walls, these were rapidly filled with a Moslem population. In Hochow, the chief city in the T'ashih country and the chief Muhammadan city in Kansu, the south suburb with its eight mosques and thousands of inhabitants soon greatly exceeded in size and importance the city to which it was annexed.

According to tradition the Salars once lived in Samarqand, but their free-booting propensities were a cause of embarrassment to their neighbours, and when some of their young men one day stole a cow, they were finally ordered into exile. Before their departure however they were presented by the ruler of Samarqand with a white camel, a sack of earth, and a flask of water. "Follow the white camel and he shall lead you to a place where the earth is as this earth

and the water as this water." For years they trekked eastward, contending against the great wastes of the desert and the hostility of strange peoples. At last one day the white camel failed to rise. They beat him vainly and then suddenly remembered the sack and the flask. These were reverently opened; the earth in the valley where they were camped was the same as that in the sack; the water in the Hwang Ho River the same as that in the flask. A mighty shout went up that their wanderings were over. They turned to the camel. He, his mission ended, had changed to stone. That the Salars actually came from Samarqand or thereabouts seems fairly certain. Their language is an old form of Turki, quite unintelligible to their T'ashih and Mongol co-religionists with whom they must converse in halting Chinese, but readily understood by the occasional Muhammadan merchant or traveller who comes from a region where modern Turkish is spoken. The Salars date their arrival quite definitely about A.D. 1370. It must have been decades, if not centuries, later before any cart penetrated into their mountainous and isolated district, and even to this day there are several Salar settlements which no cart could ever reach. An interesting example of the evolution of language is the fact that during these five and a half centuries the Turki word for cart had been lost and the Chinese word adopted into their vocabulary.

Except for a turban or black cap, which has given them the nickname "The Black Caps," the Salar men dress like Chinese; but the women have unbound feet, wear baggy trousers, a turban, frequently of a vivid colour, and often a Manchu cloak. They do not wear veils as is sometimes the case in Hochow. The little girls are generally in black trousers with a scarlet jacket trimmed in black or colour. On the site where the white camel was so miraculously changed to stone now rises the town of Ketzekung, the largest and most impressive Salar settlement numbering, it is said, between two and three thousand families. Changkakung, which we had passed on our way to Shunhwa, numbers about a thousand families and the six other *kung* or towns south of the river have about three hundred each. The smaller settlements are divided into six wards or villages, each with its own mosque; the larger *kung* into twelve. North of the river, where the country is less favourable, are five small *kung*. The total Salar population may be estimated to be between six and seven thousand families.

We spent a day at Ketzekung. The famous white camel stone proved to be a small stone in the middle of a swampy field enclosed by a crumbling wall of mud. Its loss of size we were told was caused by the chipping away of small pieces by countless generations of those who believed that swallowing water in which the stone had soaked would cure a stomach-ache; but we could see no evidence of such vandalism. Either we were not shown the true camel stone, or else imagination of high order must be placed in the forefront of Salar characteristics. Adjoining the camel-stone field were a row of tombs said to be those of the original immigrants. They were of mud and very dilapidated, but across the street rose a beautiful mosque and close by a handsome tomb erected to the leader of the great trek. In the south of China the call to prayer is given standing in the courtyard, but in the north every mosque has an open, three-storied, pagoda-like minaret which the *ahung* ascends to give the call to prayer. The minaret at Ketzekung was the largest and most beautiful of

all we saw in the Muhammadan country. The *ahung*, a venerable old man, and his *mallahs* (students) received us gravely and courteously, and after overcoming their first distrust of the camera became very cordial. Indeed throughout the Salar country we had everywhere a friendly reception, which belied the current tales of dour hostility. Unfortunately we had to return to Lanchow, the capital of the province, and could not attempt to visit the settlements north of the river. We had stayed in the west suburb of Shunhwa where we could find a Moslem inn, since these are far cleaner than the Chinese. Furthermore the suburb has always the advantage that one's morning start need not be delayed until the gates of the city are opened; nor would one be locked out at night if one's return is late. We left next day before the gates were open, picked our way in the dawn along the north wall and presently joined the road that enters the eastern gate. A few miles down the valley the road to Hochow branched off to our right up the valley by which we had entered, but the trail which we now followed headed straight for the jumbled hills which block the lower end of the valley and through which the Hwang Ho River has cut the Salar Gorges. We reached the hills and began a steep climb. A thousand feet up and we could look back over the valley and watch the Hwang Ho River gliding placidly until it suddenly circled to the north and then plunged into the passage it had carved far below us, no longer quiet and deep green as in the valley, but a rushing, froth-capped rapid. Presently the trail dropped to the water's edge and we followed the river for some distance as it pierced its way through the hills that rose higher and higher. A great eagle floated overhead. Then the gorge became too narrow again and the trail ascended into the hills cutting across spurs, around the feet of which the river rushed. In each furtive little hollow where there was some nearly level ground we found a small settlement—three houses, perhaps four, and always a mosque. And then suddenly the valley opened out a little, the hills fell back on either side, we dropped down again to the water's edge, once more deep and calm and in places frozen over, and in a few minutes we passed through the gateway of a wall which started at the river's edge and stretched away to the south, the Tibetan spur of the Great Wall of China. The tumultuous hills that form the eastern barrier to the Salar country were left behind. We hurried on a mile or so to Tahochia. It was almost dusk as we entered the village. Across the river the great cliff flamed vermilion in the setting sun.

Doorway of a Salar tomb at Naimankung

The ahung at Ketzekung

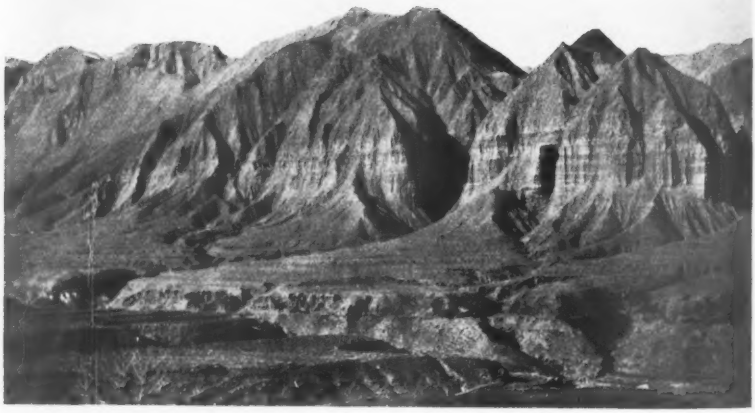
Fourteenth century tomb at Ketzekung

Doorway of a Salar tomb at Naimankung

The ahung at Ketzekung

Fourteenth century tomb at Ketzekung

Looking over the village of Changkakung



Hills in the Salar country near the Hwang Ho

NATIONAL INLAND WATER SURVEY: *A paper read at the Afternoon Meeting of the Society on 11 March 1935, by*

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THE subject of an Inland Water Survey for Great Britain has engaged the attention of the general public for the past six or eight months, mainly because the restrictions, universally inconvenient and in some cases attended by hardship, imposed on the consumption of water during the drought of last summer brought home to the national conscience in a particularly striking way the need for a thorough investigation of the available water resources and a more systematic method of distribution. Acting under the stimulus of popular opinion, but primarily in consequence of representations made jointly by the British Association and the Institution of Civil Engineers, the Government have recently announced their intention of undertaking a National Water Survey and have nominated a Committee "to advise on the progress of the measures undertaken and on further measures required and in particular to make an annual report on the subject."

The precise significance in this connection of the term "Survey," which is susceptible of more than one shade of meaning, is not indicated, and it would be idle to deny that fears are entertained lest the survey may acquire a definite bias and be limited in important respects from the fact that the secretariat of the Committee is to be located at the Ministry of Health.

The drought however is only one aspect of the matter. A few years ago excessive floods might, with equal justification, have provided the necessary stimulus. A survey is required in fact from many more points of view than those of a department of public health. It is essential for the no less important needs of industry and commerce, the possible development of hydroelectric motive power, the requirements of irrigation, fisheries, and navigation, the drainage of low-lying lands, and the prevention of floods so as to safeguard life and property and many other matters.

Properly regarded, a survey is a purely scientific undertaking necessitating special technical knowledge and supervision; and in order to ensure its absolute impartiality where so many different and possibly conflicting purposes are to be served, it should be conducted by an organization "independent of any interest in the administration, control, or use of water." This was a considered finding of the British Association Committee, who recommended the assignment of the survey to the Department of Scientific and Industrial Research, "comprising as it does such related branches of work as the Geological Survey and Water Pollution Research." They pointed out moreover that it is an organization specially equipped for, and particularly adapted to, scientific investigation of this kind.

In the following paper it is proposed to explain the full intent and scope of a National Water Survey, to indicate its fundamental principles, and to point out certain agencies which are available to render assistance in carrying it out. In so doing, attention will be directed to the work of the British Association

Research Committee, of which the writer has been a member, and to the important report and recommendations of that Committee which were laid before the Prime Minister in July last year.

A national water survey, in the technical (and only satisfactory) sense of the word, is a comprehensive and accurate measurement and complete registration, so far as may be practicable, of all the water to be found in a country, whether contained in lakes, rivers, streams, wells, artificial reservoirs, or subterranean strata and cavities. It should comprise continuous observation of rainfall, close determination of evaporation and soil absorption in different localities, systematic gauging of river- and stream-flow with computation therefrom of discharge at all stages, historical investigation into the incidence and height of floods, periodical readings of the surface-levels of lakes, wells, and artificial reservoirs, and the observation and record of the occurrence, amount, and quality of underground water, wherever it issues to the surface in the form of springs and seepage, with exploratory boring where desirable. Very briefly, a survey is a process of active research which will trace the course of water from its first precipitation or condensation on the ground as rain, hail, snow, or dew, to its final disappearance into the sea.

The scope and work of a survey

In enunciating the preceding definition, the scope of the survey has to some extent been outlined, but so concisely as to render it desirable to explain the essential features in rather greater detail and to indicate some of the objects which will have to be achieved. It can readily be seen that the survey must concern itself with a variety of physical phenomena and that it must enlist the services of several branches of science, notably Meteorology, Geology, Geography, and Topography. The following is a brief statement of some of the more important matters to be dealt with.

RAINFALL: The principal primary source of all fresh water is rainfall. Obviously then the first step of a survey is to obtain full information as to the incidence, frequency, and amount of rainfall throughout the country. Happily for this purpose there is already in existence an organization which for a number of years past has carried out in an admirable manner the functions of superintending, collecting, and publishing data obtained from a great number of stations all over the British Isles. The British Rainfall Organization, founded as a private enterprise about the year 1860 by the late Mr. J. G. Symons, was taken over by the Government in 1919 and the duties are now assigned to the British Climatology Division of the Meteorological Office under the Air Ministry. Apart from the official staff, a considerable degree of assistance is voluntarily given by private persons and local authorities who provide altogether something like five thousand observation stations. Monthly and annual totals for nearly all stations are plotted at headquarters on maps, from which charts of rainfall distribution are prepared and are published in *British Rainfall*, the annual publication of the Organization. In addition, the Meteorological Office issues the *Weekly Weather Report*, the *Monthly Weather Report*, and the *Meteorological Magazine*, together with other valuable contributions to meteorological science. The new survey will depend very largely on the information to be obtained from this efficient Organization,

which has been rightly described as having no parallel in any country at the time of its incorporation in the public service.

EVAPORATION AND ABSORPTION: An appreciable part of the rainfall is lost to practical use by evaporation in the air or absorption in the soil. Although certain observations are conducted by the British Rainfall Organization, this section of meteorological research cannot be said to have received the degree of attention it deserves, or is needed for the purposes of a survey. The 1932 volume of *British Rainfall* contains evaporation records from thirteen voluntary stations where observation tanks are in use and from five stations where evaporation is deduced indirectly from readings of percolation gauges. This is a meagre total in comparison with the rainfall records from five thousand stations. Mr. E. G. Bilham, the Superintendent of the British Rainfall Organization, who has given some consideration to the subject, has found that in the Thames Valley the annual evaporation, as measured by the difference between rainfall and run-off, is equivalent to one-third of the amount of annual rainfall plus 9·1 inches.[1] This relationship is, of course, only strictly of local application and corresponding values for other catchment areas remain to be determined. Meanwhile, in a rough and general way, engineers have been in the habit of deducting from the rainfall an arbitrary amount of 14 inches to cover losses arising from evaporation and absorption.

RUN-OFF: This term is applied to the bulk of the water which, following rainfall, escapes to the sea. It comprises all that does not disappear by percolation, absorption, and evaporation. It constitutes the greatest field of activity for the survey, for it is a regrettable fact that up to the present time there has been no department or central organization constituted to deal with direct hydrological measurements of the amount of water actually derived from rainfall. Certain water undertakings and hydroelectric power installations find it desirable to take gaugings and measurements for their own purposes, but they are a small minority and their observations are not generally accessible to the public. Moreover the records in a number of cases, more particularly as regards flood water, are imperfect and incomplete. There are large areas of country and a considerable number of streams for which there are no records at all. One of the few cases of really effective river measurement is that of the Thames Conservancy, which possesses very complete records of the flow at Teddington Weir dating from 1883. It is interesting to note that the highest flood there recorded—an abnormal incident of outstanding significance—occurred in the year 1894, when on November 18 of that year the daily rate of discharge was 20,236 million gallons. This may be contrasted with the 200 million gallons which is the lowest average daily flow. In the case of ordinary high floods, occurring every few years, the daily flow is of the order of 10,000 million gallons. These figures will give an idea of the extreme range of variation in river discharges and show how important it is, for dealing alike with problems of flood and drought, to have reliable records extending over a long period of years. Such records are in the majority of cases not yet available, and it will be the duty of those in charge of the survey

[1] "Evaporation—a brief Review of Methods and Results," Agricultural Meteorological Conference, October 1934.

to see them instituted and maintained. The obviously appropriate agency through which much of this work can be done, in the case of England and Wales, is the series of new Catchment Boards set up under the Land Drainage Act of 1930. These boards should realize that river and stream gauging constitutes one of the most important functions of their engineering departments, if their engineers have not already advised them to that effect. It is scarcely three years since disastrous floods took place in the Midlands, involving loss of life as well as destruction of property. The bursting of the banks of the Trent and the Don caused damage to the town of Derby to the extent of half a million pounds. Without adequate information as to the vagaries of river-flow it is impossible to devise preventive measures and to cope with emergencies. So far no Catchment Boards have been instituted or suggested for Scotland, and therefore other bodies will have to be looked to for assistance in supplying information respecting Scottish rivers.

This affords an opportunity of referring to the work carried on for a number of years past by a private organization, known as River-flow Records, under the direction of Captain W. N. McClean, who has published records of flow measurements in the Ness Basin and lately on the Aberdeenshire Dee. As Captain McClean has described his operations in the former of these districts in a paper [1] read before the Society a few years back, it is not necessary to refer to them in any detail here. They will be found extremely helpful in providing a basis on which the practical work of river measurement can be undertaken. Dr. Hogan, of the Department of Scientific and Industrial Research, has also prepared two useful reports on Current Meters and River Gauging, issued in 1922 and 1925 respectively. Various other publications are available, dealing with particular streams and rivers. In this connection it may be pointed out that it is obviously one of the responsibilities of an organization charged with the supervision of a national survey to see that the instruments and appliances used and the methods of observation and measurement are standardized so that results may be obtained on a uniform basis of reliability and exactitude. This is particularly necessary in cases where voluntary assistance is rendered from external sources.

LAKES AND RESERVOIRS: Here the work of the Ordnance and Geological Surveys will be of considerable assistance, in conjunction with certain maps of Bathymetrical Surveys of Scottish Lochs and of English Lakes which have been published in the *Geographical Journal*.[2] The surface-levels of the lakes and of reservoirs will need to be observed at regular intervals and the fluctuations noted so as to have a complete record of the seasonal changes. Soundings will also be desirable from time to time in order to determine any variations or alterations in the levels and contours of lake-beds.

WELLS AND SPRINGS: As regards underground sources of supply, the Geological Survey will again be able to afford considerable assistance. For nearly a century the Survey has collected well-sections and borings, and it has issued some twenty-six special County Water Memoirs. It is pointed

[1] "River Flow Records," 20 January 1930. Published in the *Geographical Journal*, July 1930.

[2] Vols. 4, 9, 15–18, 22–28, 30, 31, and 36. Also July and August 1895.

out by Dr. Bernard Smith [1] that the information received is usually incomplete, since the only powers exercised by the Geological Survey are in respect of borings and shafts over 100 feet in depth, sunk in search of minerals. The compulsory registration of all wells and boreholes of this depth has been advocated at the Aberdeen meeting in September 1934 of the British Association. Mention should be made of a thoughtful and suggestive address on that occasion by Professor W. S. Boulton on the subject of underground water supply. It is estimated that over the whole of England and Wales the total quantity of water abstracted from underground sources by public undertakers amounts to not less than 350 to 400 million gallons a day, sufficient to meet the present needs of a third of the population. The Metropolitan Water Board alone pump from 40 to 50 million gallons from the London area. The local, as well as the aggregate, effect of this abstraction therefore is a matter of considerable importance, and the study of measurable water tables, wherever possible, is a very necessary part of the duties of a national survey.

Necessity for a survey

Strangely enough, despite the experience of the drought, a good many people seem to doubt the need of a survey and ask what useful purpose will be served by making a complete inventory of the national resources. The answer is simple. A business man of any capacity will not allow himself to remain in ignorance of the exact extent of his available capital, nor will he commit himself to expenditure of any importance without a clear idea of his ability to afford it. Water is a national asset. Although in this country happily plentiful, it is not inexhaustible, and its use is accompanied by a good deal of preventable waste, while its distribution is irregular and imperfect. The time has arrived when owing to increasing demands for supplies to meet domestic, industrial, and commercial needs, it is essential to take stock, check waste, and husband resources so as to use them to the best advantage.

Domestic consumption per head is annually increasing with the adoption of higher modern standards of sanitation, such as the provision of piped supplies to houses in rural areas, and the substitution of water-carriage for the old objectionable earth-closet, the general installation of baths and of hot-water systems even in small cottage property; there is also a large quantity of water now used for washing down motor cars and for watering gardens and allotments. The present normal consumption of water in this country of a house with a piped supply, a bath, and a water-closet, is from 25 to 30 or 35 gallons per head per day. In a paper [2] recently read before the British Waterworks Association, Mr. John Bowman, Water Engineer of Edinburgh, gave it as his opinion that within the next twenty years, owing to the increased use of baths, at least another 20 gallons per head would be added to the daily consumption of water, and that in perhaps forty years' time a consumption of 80 gallons per head may be considered possible. It is not at all unlikely. In the United States of America the figure is already largely exceeded. New York, Boston, Los Angeles, and a number of other cities have a consumption

[1] Main Memorandum E, British Association Research Committee Report, 1933.

[2] "Consumption, Misuse, and Waste of Water," British Waterworks Association Annual Meeting, Edinburgh, 27 June 1934.

per head in excess of 100 gallons daily. The figure for Chicago is 241 gallons.[1] Compared with the British normal standard of scarcely more than one-tenth of this quantity, the consumption is surprising and almost startling. One wonders what the Americans do with it all.

The industrial and commercial uses of water are manifold. Apart from actual absorption in manufacturing processes, it is required as feed and condenser water for steam-engine plants, as cooling water for oil- and gas-driven plants, and as a source of energy for generating power in hydroelectric stations. Reliable water data are a necessity for all these uses, and in addition for navigation purposes, for fishery interests, and for pollution research in connection with public sanitation and the discharge of sewage and trade refuse into rivers and streams. Continuous and prolonged records of water-levels are also in the highest degree essential for flood prediction and to enable preventive measures to be taken for the protection of life and property.

The work of the British Association Committee

All the multitudinous directions in which a water survey can be of great value to the country have been known and appreciated in scientific and technical circles for a long time, and there has been a growing demand among professional men for the institution of a survey. Within recent years this demand became so widespread and insistent that in September 1932, following a discussion on the subject at the York Meeting, the British Association appointed a representative committee of engineers and departmental officials to inquire into the whole position and to consider the possible organization of a survey by central authority.

Under the Chairmanship of Vice-Admiral Sir H. P. Douglas, K.C.B., C.M.G. (Lieut.-Colonel E. Gold, D.S.O., F.R.S., being Vice-Chairman), and with Captain W. N. McClean as Hon. Secretary, the Committee made a careful investigation extending over many months into all the available sources of information, and in the following year presented their first report setting out the urgent representations which had been made from time to time during the past fifty years for the institution of a thorough examination and an efficient control of the national water resources, and pointing out the example set by the other leading countries of the world which have in operation state organizations for investigating, conserving, and allocating their water supplies. By way of exemplification of the gravity of these past representations, the Committee quoted the following significant passage from the Final Report (1921) of the Water Power Resources Committee of the Board of Trade:

"We find that the difficulty in fairly allocating the natural sources of water is becoming greater year by year in England and Wales and the evidence we have heard proves beyond doubt the urgent necessity in the national interest of some measure of control of all water, both underground and surface, in order that the available supplies may be impartially reviewed and allocated and may be made to suffice for all purposes in the future. In consequence of the increase of population, the improvement in the conditions of life, and the

[1] 'Elements of Water Supply Engineering,' by E. L. Waterman, New York, 1934, p. 16.

growing requirements of industry, the demand for water is steadily increasing, and the problem of meeting future needs is giving rise to anxiety in many parts of England and Wales."

In the light of the information which they collected during their researches, the British Association Committee came unanimously to the conclusions:

(1) That a systematic survey of the water resources of Great Britain was urgently required ; and

(2) That the survey, in order to be of maximum utility, should be conducted by a central organization, preferably under a Government department, independent of any interest in the administration, control, or use of water.

At this stage the financial position of the country precluded any possibility of the Government assigning a grant from the public funds for the purpose of a national survey, and an attempt was made in conjunction with the Institution of Civil Engineers to set on foot an organization supported by private contributions, but the requisite financial support was not forthcoming and the idea had to be abandoned. In the course of last summer, economic conditions had so far improved that a joint committee of the two bodies felt that the time was opportune for an appeal to the Prime Minister. A Memorandum was accordingly prepared and signed by Sir James Jeans on behalf of the British Association and by Sir Henry Maybury on behalf of the Institution of Civil Engineers. In the absence abroad of the Prime Minister, a deputation was received by the Minister of Health, who promised that the matter would receive the most careful consideration of the Government. The interview took place in July last and in December the Minister stated in the House of Commons, in reply to a question, that it had been decided to institute a survey. This has since been followed by the appointment of a Committee of eleven members, with Colonel Sir Henry Lyons, F.R.S., as Chairman, and a secretariat located at the Ministry of Health.

The recommendation in the Memorandum presented to the Prime Minister that the conduct of the survey should be placed in the hands of the Department of Scientific and Industrial Research was not adopted, although the Committee felt its desirability not only on the general ground, previously referred to, of the independent position of the Department, but also by reason of the scientific authority it could exercise in the selection and standardization of apparatus, instruments, and methods of measurement.

National water surveys abroad

Having thus reviewed the position as it presents itself at the moment in Great Britain, it will be instructive to turn to examples of national surveys actually in operation in other countries. During the deliberations of the British Association Committee, the writer was requested by his colleagues to prepare a Memorandum on foreign practice to accompany the Committee's first Report. This will be found in Main Memorandum B, attached as an appendix to the Report. He has since continued his correspondence with the authorities of these and other countries and obtained further information which is included in the following statement. He has also been courteously furnished with a number of official photographs of gauging stations and

operations abroad which will be shown on the screen. It will be seen that there is considerable diversity in organization and procedure.[1]

CANADA: The Meteorological Service of Canada, a branch of the Department of Marine, undertakes the record and study of rainfall. There are over seven hundred climatological and other stations maintained for the purpose of keeping continuous records of meteorological conditions, including, as regards atmospheric moisture, precipitation and evaporation. Records are published monthly and information is given free of charge.

Stream-flow measurements are undertaken by the Dominion Hydrometric Survey organized under the Water Power and Hydrometric Bureau, which is a branch of the Department of the Interior. The survey is in operation in each province of the Dominion under cooperative agreements between the Department and the respective provincial governments embodying the following main principles:

(1) The Department of the Interior carries out the general basic investigations of the survey and provides the staff and equipment for the purpose.

(2) Detailed engineering and economic investigations of water-power sites are the responsibility of the province.

(3) The location of stream-measurement stations and gauges is arranged by agreement between the Director of Water Power and the corresponding provincial authority.

(4) All hydrometric data secured by the Dominion in a province are made available to the provincial authorities and the results of the hydrometric survey are published at intervals of not more than two years.

At each metering station a sufficient number of discharge measurements is taken to enable a curve of the required degree of accuracy at all stages of flow to be drawn, in order to determine the relation between gauge height and discharge. As a rule, the daily gauge readings are taken by a local resident, who is paid a small fee for the service and sends his return periodically to the district office. Automatic gauges are used at some of the more important stations and also in remote places where no local gauge reader is available. The number of stations at present in use in the provinces is about four hundred and fifty. Many of those established in the past have been discontinued, generally because sufficient data in relation to the importance of the stream have been obtained.

As regards the cost of the survey, the provinces contribute to the expenses of the field work carried out by the Dominion, but not on a uniform basis. Publication is the sole charge of the Dominion. A series of Water Resources Papers is issued dealing with the surface water supply of Canada.

The organization of the Dominion Hydrometric Survey is used to disseminate flood warnings, especially in spring and early summer, in districts

[1] Grateful acknowledgments are due to Mr. J. T. Johnstone, Director of the Dominion Water Power and Hydrometric Bureau of Canada at Ottawa; to Mr. W. C. Mendenhall, Director of the United States Geological Survey at Washington; to M. Watier, Directeur des Voies Navigables, and Captain Wehrlé, Directeur de l'Office National Météorologique at Paris; to Dr. B. Körner, Director of the Landesanstalt für Gewässerkunde at Berlin; to Dr. C. Mutzner, Director of the Service Fédéral des Eaux, at Berne; and to the President of the Servizio Idrografico at Rome.

Germany: stream measurement from fixed bridge

Switzerland: movable platform and gauging apparatus on the River Aar

United States: water-stage recorder on the Feather River near Oroville, California

Italy: fixed gauge on the River Paglia, Orvieto

Switzerland: fixed gauge and self-recording apparatus on the River Aar

Canada: wading measurement, Monte Creek, British Columbia

liable to inundation. This entails the location of a series of coordinated gauging stations at strategic points throughout the course of the main rivers and their principal tributaries. When a level is reached which is called the warning-point, the gauge reader at each station reports by telegram or telephone to the central office and continues to report each day until the level of the water falls below the warning-point. By the observation of the times of passage of water from station to station, reasonably accurate predictions can be made, frequently several days in advance of actual flood conditions. Notices are issued to the Press and to agencies specially interested. This service has proved of great value in the saving of life and property.

Artificial storage is an important feature of water conservation in Canada, and reservoirs to control stream-flow have been constructed in many parts, principally to secure a regulated flow for water-power development, but also for logging, irrigation, municipal water-supply, navigation, flood control, and other purposes. The great majority of the numerous impounding dams have been constructed by private enterprise, but some have been built by the Dominion and provincial governments for various purposes. Specially notable in the province of Quebec is the work of the Quebec Streams Commission under the direction of which works of great magnitude and importance have been carried out to provide storage for flood waters and to regulate stream flow.

UNITED STATES: The United States Weather Bureau is not only charged with the duty of collecting information on all meteorological phenomena, including rainfall, snowfall, temperature, wind movement, etc., particulars of which it publishes, but it also obtains records of river-flow stages and issues flood predictions for certain rivers which are of sufficient length to permit of the forecasting of floods some considerable time before their actual occurrence. Works of flood prevention are in the hands of the Corps of Engineers in the War Department, and they deal with all projects of river regulation undertaken as such by the Federal Government.

The Geological Survey collects information with respect to the quantity, chemical quality, availability, and utility of water supplies, both surface and underground, with reference to its control by reservoirs or levees and to its utilization for various purposes. In general, such utilization is undertaken by private corporations or municipalities, control being exercised by the respective states over all matters of exploitation and construction. The states also control the acquirements of rights to use supplies and the distribution of water among various users. The field of control of the Federal Government is limited to navigable rivers.

For administrative purposes, the Geological Survey is grouped with other bureaus in the Department of the Interior and comprises five coordinate branches of which the Water Resources Branch, which is primarily concerned with the collection of data relating to water, is itself also subdivided into five sections: viz. (1) Division of Surface Water; (2) Division of Ground Water; (3) Division of Quality of Water; (4) Division of Power Resources; and (5) Division of Water Utilization. The Water Resources Branch maintains about two thousand nine hundred river-gauging stations, of which about two thousand are equipped with recording gauges.

The field work of the Surface Water Division is carried on from thirty-five district offices under the direct supervision of district engineers. In general, each district covers an area of one or more states, the boundaries of the districts being made along state lines in order to simplify the arrangements for state cooperation in carrying out the work; this cooperative work is paid for jointly, but is supervised and controlled by the Geological Survey, which conducts the major part of its investigational work in cooperation with about forty of the forty-eight states.

Records of the observations made in respect to surface and underground water are published by the Geological Survey.

Another body which has to deal with the administration of water resources is the Bureau of Reclamation, which constructs and administers developments for the utilization of water for irrigation, originally only as regards public lands, but since extended to include large areas of private lands. The development of water power on public lands and on navigable streams is controlled by the Federal Power Commission.

FRANCE: The collection and publication of data and statistics of rainfall measurement in France are the responsibility of the Office National Météorologique. In the Department of the Seine, there exists a special meteorological service called the Paris Municipal Service, which likewise transmits all its observations to the National Meteorological Office. In each of the other French Departments there functions, under the technical control of the National Meteorological Office, a departmental Meteorological Commission appointed to engage voluntary observers (roadmen, teachers, agriculturalists, foresters, members of the clergy, workshop managers), to each of whom is entrusted a rain gauge. These observers make every morning, at a fixed hour, a pluviometric reading and despatch monthly a copy of their daily records to the Commission which, after verification, transmits them to the National Meteorological Office. There are actually in France about two thousand observers making pluviometrical observations, but the system grows every year, and when the number reaches three thousand it will represent an average of one pluviometer to 200 square kilometres of territory (50,000 acres).

The collection and dissemination of information concerning flood and inundations, as well as the taking of hydrometric observations generally, are functions of two departments of the Ministry of Public Works (Service Central Hydrométrique et d'Annonce des Crues and the Service Central des Inondations).

Rivers navigable and "floatable" also come under the control of the Ministry of Public Works; those streams which are neither navigable nor floatable are supervised by the Ministry of Agriculture.

As regards the utilization of water for hydraulic power purposes, this is a matter which is a further concern of the Ministry of Public Works, in respect of concessions of falls to undertakings, the maximum power capacity of which exceeds 500 KW., whatever may be the main object of the undertaking, or to undertakings, the maximum power capacity of which exceeds 150 KW., when the principal object is the supply of energy for public services. In other cases, authorizations for the utilization of waterfalls are dispensed by the

Ministry of Agriculture, with the proviso that in connection with navigation canals and canalized rivers, these authorizations are accorded by decree countersigned by the Minister of Public Works, when the duration of the concession is to exceed five years.

GERMANY: In pursuance of the ordinance in respect of the national weather service (Verordnung über den Reichswetterdienst) dated 6 April 1934, the whole of the work of the meteorological services in Germany has been taken over by the German Air Ministry, which accordingly supervises the collection and publication of rainfall statistics. The Reichswetterdienst is entirely separate from, and has no administrative connection with, the National Institute of Hydrology (Landesanstalt für Gewässerkunde).

Deductions from rainfall observations for water economic purposes are still, as heretofore, the function of the respective hydrological institutes of the various German States. This requires close practical cooperation for successful treatment, and it is felt that the summarization of hydrological information respecting the important rivers in various districts, under the single control of a National office, is desirable. It is hoped in fact that this will shortly be accomplished.

Measurements of river-flow are made by the Prussian National Institute of Hydrology, which was established by Imperial decree of 14 April 1902. This was a development of the Bureau of the Committee constituted in 1892 for the investigation of water conditions in river districts particularly exposed to risk of flooding. The terms of the instruction to the Institute of Hydrology as defined by the Ministries of Public Works and of the Administration of Lands, Domains, and Forests, are as follows:

(1) The collection, uniform treatment, and completion of observations respecting the discharge of navigable and non-navigable rivers, as also the determination of the precise causes and attendant circumstances.

(2) The adaptation of the results of investigation for public information by means of publication and, if necessary, by cooperation for the solution of questions of hydro-economics.

A Yearbook ('Jahrbuch für die Gewässerkunde Norddeutschlands') is published annually giving very completely in tabular form the records of daily readings and gauge measurements, both observational and automatically recorded, of the principal rivers, viz. the Memel, Pregel, Weichsel, Oder, Elbe, Weser, Ems, and Rhine, including the Baltic (or East Sea) Coast and the North Sea Coast. Values are also given for the highest, lowest, and mean water-levels for individual months of the particular year, as also for a long series of years.

SWITZERLAND: As in several other countries, the observation and record of rainfall in Switzerland is included in the functions of a special organization; in this case, the Station Centrale de Météorologie at Zürich, which assembles the meteorological observations for the whole of the country.

Hydrometric observations, that is to say, the taking of water surface-levels in lakes and important watercourses, the calculation of discharges, the plotting

of longitudinal and transverse profiles of certain streams and of the beds of lakes at certain points (in front of their outlets and of deltas, for instance), the planimetric reading of basins with discharging watercourses, etc., are the work of the Service Fédéral des Eaux, whose headquarters are at Berne.

For the observation of water-levels there are some three hundred posts, or stations, on different watercourses and lakes. The levels are read from one to three times a day by observers (chosen locally and modestly recompensed for their services) with the aid of graduated gauge-posts installed at each station and designated "limnimétres." Over half the number of posts, or stations, are further provided with automatic gauge recorders, registering the levels (limnigraphs) graphically. The observations are communicated to headquarters, according to the importance of the station, each day or each week or each month, strong or heavy floods being specially notified by telegraph or telephone. Only the more important stations are of a permanent character; those of secondary importance are abandoned as soon as the series of observations taken at those points is considered to be of sufficient duration, from ten to fifteen years in general. The measuring apparatus is then released for transfer to some new station.

Daily discharges are computed at about a moiety of the limnimetric stations. The relation existing between the discharges and the water surface-levels at a station is determined by means of gaugings executed, in general, with the aid of an electric current meter. There is a special installation for calibrating the current meters.

The foregoing hydrometric readings are tabulated annually in the *Annuaire hydrographique de la Suisse*, which is sold at a price of 30 francs. There is also a publication, illustrated with plates and diagrams, called *The Development of Hydrometry in Switzerland*, which is on sale at a price of 20 francs. The Royal Geographical Society (as well as the Science Museum) receive copies of these publications.

As regards the control and administration of sources of water power, a law of 22 December 1916 confers on the Federal authorities the supreme supervision of the utilization of the hydrodynamic power of public or private watercourses. By virtue of this law the Federal authorities must, among other things, examine and ascertain whether projects of hydroelectrical development assure a rational use of the hydraulic forces. They must moreover investigate cognate problems such as the regularization of the flow of natural lakes, the creation of reservoir basins, the steps to be taken to preserve the exercise of river navigation, etc.

ITALY: Italy presents perhaps the most complete instance of a unified and coordinated service of hydrometry on national lines. Hydrology in that country has been studied for a long time past, the first observations of rainfall and the earliest systematical readings of water-levels dating back a couple of centuries. Coming to recent times, there were functioning in the early part of the present century, two important but independent organizations known as the Ufficio idrografico del R. Magistrato alle Acque and the Ufficio idrografico del Po. The former of these was constituted in 1908 in the Veneto province, and the latter in 1912, with its headquarters at Parma. In the latter

part of 1917 the remainder of the country lying outside the purview of the above two authorities was divided into eight compartments with boundaries along the lines of the natural watersheds. The several compartments were entrusted to as many autonomous "sections," completely independent of the local offices. Until 1923 these sections were placed under the supreme control of a special Inspectorate. Then in 1924 all the foregoing were combined in direct dependance on the Presidency of the 3rd Section of the Supreme Council on Public Works, so that from this date it can be said that the hydrographic service had completely assumed the character of a national (as distinct from a regional) organization.

The operations of the Service comprise two clearly defined departments of activity, viz. functions of a permanent character and special investigations and researches.

Functions of a permanent character consist in general of all observations, measurements, and direct determinations for the ascertainment of hydrological data. They include the following:

(1) Meteorological observations concerning the temperature of the atmosphere and atmospheric precipitation.

(2) Observations and essential measurements in respect of surface water, including the levels of watercourses and lakes, the discharge of streams, the amount of material carried in suspension (turbidity), the temperature of watercourses and lakes, etc.

(3) Observations and essential measurements of subterranean water, comprising the levels of water tables, the range of wells, the scheduling of artesian wells.

(4) Periodical publication in the *Annali Idrologici* of the results of the observations and measurments.

(5) Collaboration with the Ufficio del Genio Civile in developing the concessions of water sources and the examination of projects for important hydraulic undertakings.

Among the investigations and special research work are included the following:

(1) Determination of the geometrical characteristics of watercourses and basins, particularly areas of hydrographical basins and their distribution, with the elevations and longitudinal profiles of watercourses.

(2) Scheduling of springs.

(3) Studies and relative determinations of the national hydraulic resources, comprising a numerous but coordinated series of researches of various undertakings, which affect respectively the hydraulic resources for motive power and those for irrigational purposes and which require, as a necessary preliminary, continuous daily statistics of the resources utilized.

(4) Various investigations into special phenomena, including the publication of the results.

The number of pluviometric stations in Italy is over 4000. The number of hydrometric stations is about 750, and of discharge-measuring stations about 450, making a total of 1200 concerned with surface-water measurement.

From the foregoing condensed account of the procedure followed by six leading countries in conducting their respective water surveys it will be seen

that great importance is attached to (1) the consistent gauging and measurement of river- and stream-flow, and (2) to the publication of the results obtained so as to be accessible to all who are interested. In both these matters, for lack of organization and direction, there has been considerable neglect in this country. With the inauguration of an official authority, the defect should be remedied and those in charge of the survey should consider it an essential part of their duty to disseminate information and advice to local authorities and others engaged in the exploitation of water supplies and the control of floods. The information will be particularly valuable in connection with run-off and the yield from underground sources in any area. As regards rainfall, this course is already pursued: the Superintendent of the British Rainfall Organization undertakes to give expert advice on matters connected with rainfall. Such advice often takes the form of estimating the mean annual rainfall over a specified catchment area. Similarly, the survey authorities should be in a position to furnish the mean annual run-off from a catchment area, together with an estimate of the yield.

It is obvious that such duties will require the services of an expert staff; indeed it would largely nullify the value of a survey if it were to be limited to the mere collection and filing of records and statistics. The keynote of the organization should be Active Research.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: The lecture this afternoon is by Dr. Brysson Cunningham, of the British Association Committee on Inland Water Survey. Dr. Cunningham is a consulting engineer in private practice, and he is an expert on the question of the inland waterways of Great Britain. The desire for such a lecture arose some months ago when the question of drought was so much to the fore in the Press and elsewhere and we were anxious to get an expert to speak on that subject. There is no one who can do so with more knowledge and up-to-date experience than the lecturer. As there is prospect of an interesting discussion afterwards I will not delay Dr. Brysson Cunningham from beginning his address.

Dr. Cunningham then read the paper printed above, and a discussion followed.

The PRESIDENT: There are present a number of gentlemen interested in the subject from one scientific point of view or another. I will call first upon Admiral Sir Percy Douglas, the Chairman of the British Association Committee on Inland Water Survey.

Admiral Sir PERCY DOUGLAS: We have all listened to a most interesting paper on a subject which must appeal to us all. It is a lamentable thing that the water resources of this country are not known. For this fact, which fundamentally affects all other means or methods suggested for the supply and distribution of water, has consistently been overlooked by many of those who talk and write about this necessity of life. The British Association Committee to which Dr. Brysson Cunningham has referred and of which I have the honour to be Chairman consisted, amongst others, of representatives of the various Government Departments interested, and it was a source of gratification to me to find that the Committee was unanimous in the opinion that a survey of the water resources of the country was at the present time more necessary than ever. This opinion resulted in a joint sub-committee being formed and, without describing in detail

the work of that committee which resulted in the Government receiving a deputation on the subject, I would like to mention one result of its subsequent deliberations.

It was evident to this sub-committee that the matter of supply and distribution of water was apt to be confused with the one aspect which we were considering, *i.e.* an inland water survey, and to show clearly what we were after we compiled a memorandum, which I think might be recorded in the Royal Geographical Society's *Journal*. The memorandum definitely maintained the fact that the object of the survey was to ascertain the quantity of water present in surface and underground resources, and that the committee which we hoped would be formed to direct this survey would not deal in any way with the use and allocation of water. The functions of the committee were enunciated as follows:

1. The division of the country into suitable areas for observation and record.
2. The standardization of apparatus and methods of observation and the issue of instructions for guidance of operators.
3. The establishment of efficient gauges and measuring apparatus at convenient points on rivers and watercourses.
4. The general direction of operations, including—
   (*a*) Gauge readings of the rise and fall of water levels in rivers and streams;
   (*b*) Measurements of stream and river flow;
   (*c*) Level readings of lakes and reservoirs;
   (*d*) Compilation of lists of springs, wells, and underground water sources with records of yield;
   (*e*) Calculation of discharges of rivers and streams with compilation of tables therefrom;
   (*f*) Taking of profiles of lake and river beds.
5. The assemblage, collation, and publication of the records and results obtained from the various local centres.

I am sure that I only voice the hope of the members of my committee who have unanimously approved this memorandum that it will prove to be a help and guidance to those who now have the most important and responsible task of directing this survey.

The PRESIDENT: I now call upon Dr. Mill, whom the Society knows so well. He is a Member of our Council and was at one time Director of the British Rainfall Organization.

Dr. H. R. MILL: I have very great pleasure in associating myself fully with all that Dr. Cunningham and Admiral Sir Percy Douglas have said on the subject of a water survey. This Society has looked upon the water resources of the country as being part of the subject-matter of geography. Forty years ago there had been innumerable committees of the British Association, and many representations to Government and to the Ordnance Survey on the matter of the measurement of the amount of water in the lakes of the country, with no result. The absolute impossibility of getting this done by the official authorities led to this Society commissioning Mr. Heawood and myself to go and sound the English lakes, which we did in a couple of holidays. The results were tested and accepted by the Ordnance Survey, and our contour lines of depth have been shown on the 6-inch maps of the Survey from that day. The Royal Geographical Society also, just before the War, conducted a series of researches through its Research Committee under the chairmanship of Sir Aubrey Strahan, on the rainfall and river flow of the Exe and the Medway. Valuable information was collected in that way and printed in a special publication of the Society.

I may say that when I took over the direction of the British Rainfall Organization in 1901 I did so not so much because of my interest in rain, though that was considerable, but because I wanted an opportunity to put to a strict quantitative test the influence which the forms of the land exerted upon mobile distributions; and there is no more mobile distribution on the face of the Earth than the falling rain. As a result, it was possible to adopt new methods and reorganize the work of the Rainfall Organization. The introduction of cartometric methods of measuring the amount of rain falling over given areas was found helpful for this purpose. By sub-dividing counties, under which the records of rainfall were formerly published, into catchment areas of rivers defined by the watersheds, it was possible to use these lists of records for the purpose of bringing together all the rain gauges in the basin draining into each river. This was done in the hope that ultimately some such survey as that which has been outlined this afternoon would be set on foot.

Just after the War I was a member of the Water Power Resources Committee set up by a defunct and forgotten ministry called the Ministry of Reconstruction which, so far as I know, never reconstructed anything, and by the Board of Trade, which afterwards was joined by the Local Government Board, now the Ministry of Health. We held meetings for two or three years and produced several interim reports and one final report. We took evidence and collected statistics, and my copy of the collected evidence and statistics weighed just half a hundredweight when I put it away never to look at it again. The report was published in 1921 and many recommendations in it were like those of the British Association Committee which you have heard about this afternoon. So far as I know, little has come of it and it has inspired me with a profound doubt as to the value of Government committees of inquiry. I hope however that there are better prospects for the particular Committee which has now been appointed to consider the question of a water survey, having so able a chairman as Sir Henry Lyons. He is so completely acquainted with the methods of studying water resources in the most ancient of all hydrographical areas, the Nile, and he has so thorough a knowledge of all the official ramifications of the cognate bodies in this country, that he may well succeed in setting up a practical service.

I was gratified to hear the good report that was given of the state of the British Rainfall Organization. We have certainly been able to make an effective small-scale map of average rainfall; but the organization is still far from being in a position to afford complete knowledge of the rainfall of the country. There are extensive areas which have not yet been adequately supplied with rain gauges.

In conclusion, I hope that whatever decisions the official bodies to be constituted may take, they will see to it that the actual carrying out of a water survey is given to young men full of enthusiasm and ambition whose life will be made or marred by the success or failure of their efforts, and that they will be left free from harassing restrictions and unnecessary routine in order to put their whole souls into the work. I am perfectly sure that such work as has been done by Captain McClean on the Inverness and Aberdeenshire rivers is the kind of thing that we ought to encourage, making it the basis, under instruction as to comparable and standardized methods, of a complete record of the resources of the country as regards water.

The PRESIDENT: Sir Henry Lyons, to whom Dr. Mill referred, is the Chairman of the Ministry of Health Advisory Committee, and Treasurer of the Royal Society. We hope he will be kind enough to address us.

Sir HENRY LYONS: First, I should like to thank you very much for giving me the opportunity of hearing this paper. It is of very great interest, of course.

Not only would it have been so under any circumstances, but especially as the Inland Water Survey Committee is just beginning its meetings.

The urgency of a water survey in any country varies considerably of course with the conditions of that country. The Nile has already been mentioned, and in Egypt, where the whole population is absolutely dependent upon the Nile for its water, it is not surprising that the dwellers in the Nile valley began to measure and to record the levels of the Nile floods very nearly sixty centuries ago. To-day such records are as all-important as ever. Dr. Mill was so kind as to allude to some work I did there in connection with the gauging of the waters of the Upper and Lower Nile something like thirty years ago. In the continental countries of Europe the large rivers fed by the seasonal rainfall or the snow melting on high ground give rise to strongly seasonal flood phenomena; consequently people in those countries were some time ago obliged to study the hydrographical conditions of their countries. Some of the finest work that has been done and published up to the present is that on some of the German rivers.

Great Britain as an island country with very much less extreme conditions, with a rainfall that is very fairly regularly distributed throughout the year, has not felt the urgency of a careful survey of her water resources until comparatively recently. I do not mean to say that such a survey is not long overdue now, for it is; but the conditions have been, and are, rather different from those of some other countries where a much more elaborate organization already exists.

The lecturer, I think, was rather disappointed that the form that things have taken was not quite that which the British Association Committee recommended. I cannot enlighten him, I am afraid, at the present moment because my colleagues (several of whom I am glad to see here) and I have, up to the present, only met on a single occasion. Therefore I can hardly voice either their views or my own to any useful purpose. I think all we can say for the moment is "Wait and see."

When I read the recent annual report of, and heard Dr. Cunningham's reference to, the Department of Scientific and Industrial Research it came into my mind very strongly that, with the amount of detailed research that the Department is initiating and then fostering until it can be taken over by industrial or other agencies, there is little hope that that Department would care to undertake a large administrative piece of work which must inevitably comprise a very large amount of detail, as Dr. Cunningham would wish. I have no authority to speak for the Department of Scientific and Industrial Research, but it came into my mind as I read its report that whoever has the water survey to do has always the assistance of the National Physical Laboratory for calibrating instruments, etc., at its disposal. I am afraid I cannot say anything more at the moment except that I am grateful to you for having given me the opportunity of hearing this very interesting lecture by Dr. Cunningham, who has put in a very convenient and concise form the essential scope and the aims of any water survey for this country.

The PRESIDENT: Captain McClean, as you have heard, has done an immense amount of work in the direction of river gauging, on his own initiative, and we are greatly indebted to him for it. Would you be so good as to address us, Captain McClean?

Captain W. N. MCCLEAN: I should like, first of all, to say how much I appreciate Dr. Cunningham's paper and, of course, the very kind remarks he has made in regard to my work. At the same time, I should like to thank Dr. Mill very much for his reference, and perhaps it would be interesting if I tell you a little of what has been done for river-flow records by my little organization which is really dependent upon young men, as Dr. Mill would wish it. At the present

time I have two surveyors who are throwing themselves into the work and are very keen on it.

In 1912 I began river-flow measurements because it was not possible to obtain correct quantities for hydro-electric schemes without run-off records. I chose the River Garry of 150 square miles catchment for a first experiment. Water was abundant, one rain gauge having an annual average of 164 inches. There was large natural storage in the two lochs and great possibilities for water power. The results of that survey and three years' records were published by the Institution of Water Engineers. In 1929 the survey was extended to cover the Ness Basin of 700 square miles. Water-level recorders were installed at suitable sites and the flows of the Garry from 150 square miles, the Moriston 150 square miles, and the Ness from 700 square miles, were measured from low-water to flood. The twin-punt gauging apparatus, shown on a lantern slide by Dr. Cunningham, was designed in my office and constructed at Fort Augustus. It was developed to suit the conditions on these rivers and fitted with a streamlined section rod capable of measuring high velocities at a depth of 17 feet. The apparatus, which is easily transportable from river to river, has done its work remarkably well.

But, quite apart from the actual work, the most difficult matter has been to organize the survey and records: to get on to the Ness rivers and to obtain any help at all was quite a big problem. At one place I was told that I must remove my tackle the next day. A little friendly talk ensued, and it ended in my having to pay £10 a week to those who had the fishing rights. Such incidents make it difficult to organize a survey. At any rate, something very considerable has been accomplished in spite of the difficulties. There are eight recording water-level gauges at different sites on the Ness Basin and many other gauge posts. These have to be kept up entirely by my organization. No central authority has yet taken over the job in any way. I have been hoping a local organization would be created to take charge at least of the observations. All the records have been maintained; but after two years I found it impossible to continue the publication with my small staff. I have been very successful on the Aberdeenshire Dee, with the help of the Fishery Board for Scotland, the Dee Fishery Board, the Department of Health for Scotland, and the Water Authority of Aberdeen. The flow-gauging began after two years of preliminaries. The water-level recorders were put in for me by the Water Authority, and the Fishery Board are putting in others. The whole of the maintenance and observational work has been taken over by people in Aberdeen. It only remains for me to complete and publish the records. The slide shown this afternoon depicts the best form in which I think the records can be presented and published. I will not enter into detail; I merely point out that in that diagram there is every bit of information which any research worker can want for purposes of comparison of rainfall or run-off or for the storage which may happen on an area, or in any other way.

Dr. Cunningham has given in his paper a full description of what is done in foreign countries. The United States of America have very much bigger rivers than many countries, and therefore their gauging installations are costly. It may interest you to know that so far as this country is concerned I see no reason why the equipment should be anything like as costly. I got out some rough figures applicable to a river such as the Aberdeenshire Dee which has a catchment of 500 square miles. The equipment of a gauging station with water-level recorder and gauge posts, costs £50; and the complete gauging of the river, from low-water to high flood, can be done correctly and well for £400. That means a total of £450; and, translated into interest on capital, that means £25 per annum.

Maintenance and observations only cost £5 per annum, while the office work involved works out at £20 per annum. Quarterly records produced as shown on the screen, with all the data, may come to as much as £50 per annum, and the heaviest part of the work in producing those records is on the rainfall side. Certain improvements are required in the suspension of meters and so on, but no doubt when the work is taken seriously in hand such improvements will be made. The rod, as against the wire, is another point of importance. With high velocities the wire-suspended meter and weight drift all over the place and the values given are too high; in fact, I am suspicious of the wire suspension and do not use it without comparison with some steady current meter.

I fear I have spoken at some length, but I wanted to make it clear that river survey is already being done very efficiently by my organization and in a manner which can be taken over at any moment, as rainfall has been taken over, by a central organization or department. I see no need for delay. But of course that brings you to the difficulty with all such surveys. It is necessary to get everybody persuaded of the necessity of the work. I take it that will be one of the most difficult things the new committee will have to undertake. There are so many interested in the administrative and other aspects, who want to know just why the survey is necessary and who is going to pay for it. There are many other points on which I could touch, but I leave those to other speakers.

The PRESIDENT: I call next on Mr. Griffiths, the engineer for the Thames Conservancy.

Mr. G. J. GRIFFITHS: I have been associated with the Thames Conservancy for thirty odd years, and this matter is one which has been always very dear to my heart insomuch as I have grown up with it and seen the necessity of a water survey. Being always in the difficulty of having to put a brake on those who wanted to take away the underground waters and deplete the rivers, obviously the more information we can have on such a matter as this, the better.

I want to say, first, how much I appreciate Dr. Brysson Cunningham's paper. I am absolutely with him on the broad lines which he has laid down, and hope, with Sir Henry Lyons, that we will do our best to give you some result. There is no doubt, from one's experience in dealing with rivers where there is either too much or too little, that there has got to be some coordination. In the case of the Thames we are always in difficulty in that connection, and when one is dealing with a water supply 60 per cent. or thereabouts of which is needed by a population of some $7\frac{1}{4}$ millions, water becomes a very important factor. Dr. Mill expressed the hope that there would be some young enthusiasts who would take the work on. I can tell him that his hope has already been fulfilled insomuch that I know three rivers on which, within the last few months, gauging has been started on lines similar to those adopted in regard to the Thames. I do not say those are the right lines by any means; I am only telling you that work has already been carried out on those lines, and by reason of the fact that we have a larger experience than many others. I feel sure with the support of the National Water Survey Committee that sooner or later you will find more and more young enthusiasts willing to give you the results for which you ask. Obviously if there is an inland water survey we shall know whether we are likely to deplete the subsoil or lower strata and, altogether, those concerned will not be so much in the dark as at present. Again, so many ask why there should be floods. Recently some good people who had bought a house in an area which on the Ordnance Survey map was shown as liable to floods asked me to go and see them. When I went they said: "Do you know, last week the water was up to the steps of our house." I said they would probably have it through the house before long, whereupon they said: "Do you mean to say we are going to have greater floods

than we had last week?" I replied: "Probably much worse." And then I was asked, "Who is responsible?" All I could do was to point up above. Really, if you had the experience the Thames Conservancy have you would all agree that it is absolutely necessary that there should be an inland water survey of this country, and if we work on the right lines, future generations will be in possession of the information so essential. I have great respect for the water companies, but it cannot be gainsaid that we as a nation are very haphazard in our methods of water supply. When there is a definite water survey of the country, then those responsible for the water supply will be able to allocate water as may be necessary. A few years ago when we had a very bad flood in the Thames valley one good gentleman out of the many who came to me suggested that there was one method I had not so far adopted. He suggested that if I provided a number of small reservoirs about 6 feet deep down at Sunbury, Hampton Court, and round about there—there is not much land for the purpose, by the way—and then got a number of water-carts I could easily take the water out of the river and put it into the reservoirs, and there would be no floods! I could tell you other such true stories, but I am trying to give you a general impression that an inland water survey is really very necessary.

In many cases when water authorities have come along and wanted to take water out of the sub-soil we have had to set limits to that, so that they should not deplete the rivers. It is necessary to hold the balance between the rivers and the water supply.

Then of course there are many points in connection with land drainage; we have to hold the balance there, too. Unless we know what our run-off is, how is it possible to tell whether we are overdraining or underdraining? We on our part have learned a great deal on the subject and we are learning more every day. We have very useful information in regard to rainfall. We have established a chain of wells throughout the high lands so that we can get an idea as to the quantity of water stored in the pervious hills, and we shall continue the chain round the Cotswolds, the Chilterns, and down in the valleys in order to get some idea of the underground hydraulic storage; and as we proceed surely the information obtained will be of value to future generations. We are very dependent on Dr. Mill, very dependent indeed. He furnished us with records over a very large part of the Thames valley, which are extraordinarily useful and have enabled me in my particular case to deal with the River Wey and to design the weirs from the point of view of the run-off from the impervious or pervious areas. That was justified during the month of December, when we were able to prove whether our calculations were right or wrong. Had I not had the information supplied me by Dr. Mill and our own records as to rainfall, I should not have been able to design the weirs on that river. I want to thank you very much indeed for your paper, Dr. Cunningham; and I thank you, sir, for allowing me to say what I have.

The PRESIDENT: Dr. Bernard Smith has made a special study of underground water problems, and we should like to hear his views.

Dr. BERNARD SMITH: I wish to add my congratulations to those of the previous speakers to Dr. Brysson Cunningham upon his excellent summary of the scope of, and necessity for, an Inland Water Survey, and of the measures that have been taken abroad to deal with both surface and underground waters. I should say that in this country, relatively speaking, underground sources of supply are of more importance than in most of the countries quoted, where there are either great rivers to be controlled and great lakes, or the topography is such that impounding schemes for hydraulic power purposes are feasible and, in the absence or scarcity of cheap fuels, desirable. In Britain the most obvious thing

to do is to measure the actual river discharge—the water is at the surface; it can be seen and its vagaries studied. So long as there are few or no reliable and consistent data under this head, it is clear that one's first task should be to obtain them as quickly as possible; and the work might be continued for ten to twelve years, to cover at least one sun-spot cycle. But, speaking as a geologist and quite unofficially, it appears to me to be equally important to study the occurrence, amount, and vagaries both in place and time of the underground waters.

I often wonder how many people realize that during the period of an "official" drought most of the rivers covered by that drought, even the Thames itself, would have dried up—almost as completely as many do in Australia between periods of heavy rain—before the first week of the drought was over, were it not that such volume of flow as they actually possessed was entirely maintained by the underground waters! London takes about 82 per cent. of its water from the Thames and the Lea, and 18 per cent. from wells, springs, and gravel beds; but is it known what proportion of the water abstracted from these rivers is run-off, and what proportion is from the underground sources which have added to the flow during wet periods and maintained it during dry periods?

Considering any isolated week of heavy rain accompanied by floods, one might measure the discharge of a catchment at a certain figure—the bulk of the water coming down would be run-off; but if one considers the whole year the actual amount of water passing to the sea would comprise, in addition to run-off, almost the whole of the percolation for the year, less the amount actually pumped from wells, or entering the sea direct from underground. Dr. Brysson Cunningham states, for example, that the run-off comprises "all that is not lost by percolation, absorption, and evaporation." My point is that (with the exceptions mentioned above) practically the whole amount which percolates underground in a normal year (especially one following a "wet" year) is not lost but is returned to the rivers; yet often it seems to be measured as part of the run-off, or barely escapes that danger. It appears therefore to be clearly necessary to measure as accurately as possible the amount of percolation, and be able to predict at what points and at what times it will be likely to return to the rivers in greater or less amount. For example, the flows of some streams during dry periods may be maintained by springs issuing strongly owing to the rains of a month or two earlier, with subsequent rise of the sub-surface water-tables.

All this requires research, and probably more intensive research is needed for the study of underground waters than for the surface ones, and this for several reasons: (1) The waters are concealed. (2) The rocks in which they occur cannot be labelled just "pervious" and "impervious," as many people seem to think. Some are much more pervious than others, and so-called pervious strata may contain impervious layers, or *vice versa*. (3) The location and amount of underground water, even in a well-recognized aquifer, such as the Chalk, will vary with the changing lithological characters of the bed, its elevation, its sculpture at outcrop, and its geological structure—and these factors will have their influence on the yield, in some cases quite apart from the quantity of water present.

In conclusion I might indicate a few lines of research which, to quote Dr. Cunningham, go beyond "the mere collection and filing of records and statistics," and which in most cases require the services of hydro-geologists to ensure the greatest possible accuracy: (*a*) Contouring of surfaces of water-bearing beds beneath cover. (*b*) Drawing *isopachytes*, or lines of equal thickness, in such beds. (*c*) Contouring water-tables, and separating out "parched" water-tables. (*d*) Mapping out areas in which water is artesian or sub-artesian. (*e*) Mapping springs and seepage lines. (*f*) Mapping areas either in outcrop rocks or beneath

cover, where the yield of water is poor, as in synclinal areas of Chalk, or plentiful, as in anticlinal areas. (*g*) Mapping areas, usually beneath cover, where the waters of any particular stratum or formation change in mineral character and become softer, harder, more ferruginous, etc., or even non-potable—but perhaps eminently suitable for certain industrial purposes.

Research on these lines has already been carried out in many instances; but much more could be accomplished with greater coordination.

The PRESIDENT: We have had a very interesting discussion. Time does not admit, unfortunately, of our continuing the debate any longer, so I have only to ask you to join in thanking Dr. Brysson Cunningham very much for a most interesting paper, and the speakers for adding so much to the interest of the lecture by speaking from their various points of view. I have no knowledge of the technical aspects of this important question. We are told that when these survey operations are fairly on their way, or complete, we shall have at hand all the information we require, but from the point of view of the man in the street it is the question of distribution which is so hard to understand: how the excess of water in one place is going to be used to remedy dearth of water in another. I imagine that that subject will be dealt with in the statistics that will be got out.

Another point—very briefly. I am not at all aware what is the ordinary method in this country of keeping the banks of rivers in proper condition. I have had a good deal to do with river banks in Mesopotamia, and there the practice was to raise the banks to protect the land against floods. Consequently there was a gradual rise of the bank, and that phenomenon hit us very hard during the War, as the river gunboats could not use their guns owing to the height of the banks. The other method is to dredge the channel and leave the banks alone. I do not know which method is adopted in England. I call upon Dr. Cunningham to say anything he desires to add in answer to the remarks that have been made.

Dr. BRYSSON CUNNINGHAM: I have to thank the speakers and the audience generally for the very kind reception given to a paper which I am conscious possesses a number of defects. I am grateful to the speakers who amplified the directions in which the survey could be usefully carried out. There are no points of major importance to which I need refer.

The general question of an inland water survey is so extensive and presents so many aspects that one individual cannot possibly be an authority on every branch. I feel sure the suggestions thrown out by speakers who followed me will receive the careful consideration of the members of the Advisory Committee on Inland Water Survey, and that they will do their best to make the Inland Water Survey a really representative undertaking, an undertaking which will be not only of scientific value but a matter of confident appeal by all who have to deal with questions in which water has to be taken into account. There are many ways in which one could enlarge upon that topic, but I will refrain from doing so now.

The PRESIDENT: We will now just thank Dr. Brysson Cunningham, and that will conclude a most interesting afternoon. Thank you very much indeed, Dr. Cunningham.

JAN MAYEN ISLAND

E. G. BIRD

A Summer Visit in 1934

R. B. CONNELL, my brother C. G. Bird, and I visited Jan Mayen last summer and did a considerable amount of natural history work on the island. We reached the island on July 8, on board the sealer *Wildflover*, sent out to relieve the Norwegian wireless and meteorological station, and left on August 28 on board the sealer *Saelbarden*, which was returning from relieving the Norwegian trappers on the East Greenland coast and came specially to Jan Mayen to pick us up. For arranging these two journeys for us we are greatly indebted to Mr. P. Thrane, of the Vaevarslingen for Nord-Norge, Tromsø, and to Dr. Adolf Hoel, of the Norges Svalbard- og Ishavs-Undersøkelser, Oslo. Of the many people who gave us much invaluable assistance we are specially indebted to Mr. J. M. Wordie, whom I have also to thank for much help in the preparation of the second part of this paper.

Our geographical work was confined to an attempt to complete some measurements of the movement of the South Glacier which had been commenced by the Austrian Polar Year Expedition of 1933, but which they had been obliged to abandon owing to bad weather. Although we succeeded in finding their two fixed points on the lateral moraines no sign could be found of the line of marked stones which they had placed across the glacier. It was unfortunate perhaps that they did not use stakes instead of marked stones, as the latter could hardly be expected to remain *in situ* during the winter and the thaw which follows in spring.

By borrowing a small rowing-boat from the Norwegian station we succeeded in confirming unquestionably Mr. Wordie's opinion that Bear (Baren) Gat, at any rate as portrayed on the Austrian Map (see page 555), does not exist. Another point perhaps worth mentioning is that my brother obtained a photograph which shows quite clearly that the Pilot Boat rock is situated on a ridge (presumably the rim of an old crater) which runs straight out from the coast. This could only be seen when the wind was in certain directions and does not appear to have been noticed before.

It has always been known that the Dutch had a whaling station on Jan Mayen, and during recent years it has been rumoured that perfect skeletons of the now almost extinct Greenland Whale (*Baloena mysticetus*) were to be found on Jan Mayen and would be worth fabulous sums if brought home to museums. We examined all the whale remains with some care and can now set this rumour at rest once and for all. With the exception of one or two very poor remains on other beaches the whale skeletons are confined to Walrus Gat, where they are strewn all over the beach. Most of the skulls were partially covered with sand. We excavated a large number and obtained a very good series of photographs. These have been identified by Mr. F. C. Fraser of the British Museum (Natural History). The majority are of the Greenland Whale (*Baloena mysticetus*) while at least two are a species of *Baloenoptera*, probably the Blue Whale (*Baloenoptera musculus*), and one skull on the beach some 1½ mile east of Walrus Gat is of the Bottle Nose Whale (*Hyperoodon*

rostratus). Unfortunately however these skulls are quite valueless as they are all in a very poor state of preservation. Their beaks are all broken off and a good blow with a spade is usually sufficient to break off large bits from the skulls.

While mentioning the Dutch whaling station it may be of interest to note that Scoresby ('Account of the Arctic Regions,' 1820, vol. 1, p. 167) in recording some volcanic action says "... this fact serves to account for some strange noises heard by seven Dutch seamen who attempted to winter here in the year 1633–4. In the beginning of the night of the eighth of September, in particular, they 'were frightened by a noise as if something had fallen very heavy upon the ground but saw nothing.' This instead of being a fall of an iceberg as some have supposed, was probably a volcanic phenomena." At Walrus Gat one afternoon I was suddenly aroused by a similar terrific noise, but being on top of the cliffs I was able to see that this was caused by the collapse of a large portion of the vertical cliffs which fringe the central part of English Bay. As the Dutchmen were also living in Walrus Gat it seems not unlikely that it may have been a similar fall that they heard.

We succeeded in making a fairly complete collection of birds, and work was also done on their feeding and parasites. New to the island were the Grey Lag Goose (*Anser anser*), the Pinkfooted Goose (*A. brachyrynchus*), the Barnacle Goose (*Branta leucopsis*), the Wigeon (*Anas penelope*), the Knot (*Calidris. c. canutus*), and the Greater Blackback Gull (*Larus marinus*). In spite of both the Austrian Polar Year Expeditions' opinion that the North Lagoon was void of animal life, we succeeded in confirming a rumour that a trapper had caught "salmon" there, and we brought home to the British Museum a number of specimens from the lagoon of a land-locked form of the Arctic Char (*Salvelinus alpinus*). Our success in this was almost entirely due to the advice of Dr. E. B. Worthington as to the right kind of nets.

A large collection of plants proved to be fairly complete and contained thirty-eight species of vascular plants and many mosses and lichens. The flowers included two species new to Jan Mayen: *Cerastium cerastiodes* and *Trisetum spicatum*. A small geological collection was made to supplement collections in the Sedgwick Museum, Cambridge, and the British Museum.

Some further notes may be of help to future visitors. In selecting a base, water supply must always be the chief consideration. The amount of surface water on the island appears to vary greatly from year to year. This year was extremely dry. The South Lagoon had no water in it at all. Though it has been said that water can be got by digging almost anywhere on Jan Mayen, this was very far from being the case in 1934. We made our base at Camp Dobbel, where an old trapper's hut provided an excellent working room. We had to depend for our water on a small trickle which came down the side of the adjacent hill but which was quite adequate if collected by a pipe into a barrel. In a dry year such a supply is not likely to be improved upon unless one camps beside the North Lagoon, where there is also an excellent hut; but this site is very cut off from the rest of the island. The Norwegians at the wireless station on the other side of the island also experienced the greatest difficulty in getting water last summer. In fact we doubt whether our site could be improved upon, especially as it is very centrally placed.

Typical Jan Mayen flora

The skull of a Greenland whale (*Balaena mysticetus*)

Looking south-west from the top of Danielsen's crater

The Beerenberg from Camp Dobbel

A rowing-boat which we found on the island proved invaluable to us, as much of the coast consists of impassable cliffs. We should strongly advise any future visitors to take either an outboard motor or a motor boat. The former would probably be preferable. Unless a very large motor boat was taken and kept at anchor in one of the small bays (only very few of which offer any shelter at all) a light outboard would be far easier to beach in the very heavy surf which is such a common feature. Some form of motor boat would prove well worth while as without one it is almost impossible to reach the cut-off northern part of the island which is relatively unknown.

Corrections to the Jan Mayen map

Mr. Wordie and I have recently compared the modern maps of Jan Mayen with the older maps available. The two chief modern maps are the 1 : 100,000 map of the island published by the Austrian Polar Year Expedition of 1882–3 as a result of a survey made by themselves (Admiralty chart No. 432; now cancelled but printed privately upon special request), and the 1 : 369,830 inset to the Spitsbergen Chart (Admiralty chart No. 2751) which is based on the same survey but has the names translated into English where possible. Comparison of these two with earlier [1] maps shows at once that considerable confusion has arisen over names, mainly due to the Austrians ignoring many of the older names and replacing them with names of their own. These changes have unfortunately been carried on in the smaller chart and in various sketch-maps illustrating papers on the island. As far as the survey of the island is concerned the delineation of the coast on the Austrian Map is excellent, except in the case of Bear Gat (see below). But they failed to carry sufficient tie lines across the island, so that whatever their beautiful draughtsmanship may suggest, the interior detail of the island is extremely inaccurately represented. The object of my map [2] is merely to show the corrections to the place-names which it is hoped will put an end to the existing confusion and be followed in future editions of the Admiralty chart. My map is only a sketch-map with the coast-line based on the Austrian survey (again excepting Bear Gat), and no attempt has been made to give an accurate representation of the interior of the island as no accurate survey exists. Some of the more prominent features have been sketched in and their names given. Other features have been omitted since they do not appear on the smaller Admiralty chart, and as they first appear on the Austrian Map and were first named there, no question can arise as to the correctness of their names. I have thought it useful to include the positions of the trappers' huts, and have named them after inscriptions we found on them, or in the case of those we did not visit I have used the names given on a sketch-map in the Norwegian account of the island ("Jan Mayen" utarbeidat av Norges Svalbard- og Ishavs-Undersøkelser. Meddelelse No. 7. Saertrykk av *Norsk Geografisk Tidsskrift*, Bind 11, Hefte 7, 1929).

Some notes on the reasons for the changes I have made are given below. Two alterations and one addition have been made to the interior of the map.

[1] Blaeu, "Atlas Major," vol. i, pp. 19–21, Amsterdam 1665; and William Scoresby, Junior, "Account of the Arctic Regions," vol. ii, plate 6, 1820.

[2] Deposited in the Map Room, R.G.S.

The height of Beerenberg has now been accurately measured by P.-L. Mercanton ("Encore la vraie Altitude du Beerenberg de Jan Mayen," *Arktis*, 1930, p. 72), and is 7460 feet (=2274 metres). As Mr. Wordie pointed out (*Geogr. J.*, vol. 59, p. 185), Professor Mohn, who visited the island in 1877, was not justified in altering Scoresby's old name Esk crater to Vogt crater. The Austrians unfortunately followed Mohn and misplaced Esk crater to a point farther inland. I have put in the name Ullereng lagoon for the small lagoon some 2 miles east of the Norwegian station. This name appears on no map but is in common use among the Norwegians.

Beginning at Cape North East and working around the coast clockwise, the changes in name and points of interest are as follows:

(1) *Cape Fishburn.*—The small Admiralty chart (No. 2751) has changed a number of Capes into Pts., *e.g.* Cape Fishburn has been changed to Fishburn Pt. As there appears to be no good reason for this I have reverted to the older names. This also applies to Capes Hope, Traill, Vienna, Rudson, and Cross.

(2) *Great Wood Bay.*—Admiralty chart No. 2751 is correct in using this old name and not Driftwood Bay as in the Austrian map (Admiralty Chart No. 432) and Mr. Wordie's map (*Geogr. J.*, vol. 59, p. 184).

(3) *Bear Gat.*—The name Bear or Baren Gat appears on all the older maps. Dr. F. C. Wieder, of Noordwijk, Holland, tells me of the word *Gat* that "In navigation it may be used for any break in the coastline observed from the ship, whether it means a bay, small or wide, a thoroughfare, or even a larger water such as the *Katte-Gat* between Norway and Denmark." In this case it is not quite clear in what sense it was used, but it appears to be in the sense of a thoroughfare between Cape Traill and the Pilot Boat Rock. The latter is marked on the old maps as being just off Cape Traill, though in actual fact it is so far from Cape Traill that the idea could not be applied on a correct chart. The Austrian Survey (see both Admiralty charts) shows it as a small bottle-necked bay just south of the Schiertz Topp. As mentioned in the first part of this paper, by using a boat we quite conclusively proved that such a bay is non-existent. As therefore this name could not be applied in either sense on a correct chart I have omitted it completely.

(4) *Ten Tents Bay.*—The oldest maps call this bay South Bay, but as this name is now universally used for the most southerly bay, this next name is used here. It was first used by Scoresby with reference to the whalers' tents he found here.

(5) *Seven Hollander Bay.*—The Austrians in 1883 erected a cross in this bay in the memory of the Seven Dutchmen who perished wintering on Jan Mayen in 1634. They also named the bay in their memory. It may be of interest to note that they were mistaken in their belief that the Dutchmen wintered here. Their graves and bricks of their houses can still be seen in Walrus Gap.

(6) *Walrus Gap.*—The Admiralty Chart No. 2751 gives Walross Gap. As this map uses all other names in their English form "Walross" should surely be "Walrus." I have retained the word "Gap" because, although not usually used in navigation, it seems to give the best English rendering of the very wide Dutch word *gat* (see under Bear Gat).

The most serious errors however have occurred on the N.W. Coast. All

later maps have followed the Austrians here and provide an excellent example of how the correctness of a map is apt to be taken for granted and of how easily serious mistakes become perpetuated. The two chief capes were named on the older maps Cape North West and just south of it Muyen's Cape. The Austrians however ignored this latter name, called the northernmost of the two Cape North and for the old Muyen's Cape substituted Cape North West. On my map I have replaced the old names so that note (7) is *Muyens Cape:* old name replaced for Cape North West of Austrian Map (both Admiralty charts).

(8) *Cape North West* replaced instead of Cape North of Austrian map.

A more serious error still however was made in the case of the Bays of this part of the coast. Any one who examines Scoresby's map with any care ("An Account of the Arctic Regions," 1820, vol. 2, plate 6) will see that his West Cross Cove is the bay named East Cross Cove on both Admiralty Charts and that his East Cross Cove refers to a smaller bay some 2–2½ miles east of that bay. West Cross Cove appears on the Admiralty charts as the bay just north of Cross Cape. Since the Austrians' mistake has been universally followed I have not thought it possible to make such a large change on my own map and have reluctantly allowed the Austrian error to stand.

REVIEWS

EUROPE

MIDDLESEX: Old and New. By MARTIN S. BRIGGS. *London: George Allen and Unwin* 1934. 8×5 *inches;* 312 *pages; illustrations and map.* 8*s* 6*d*

Mr. Briggs' purpose is to arouse the inhabitants of Middlesex in defence of the last remnants of their county's countryside. This he attempts by recounting its past associations, especially in relation to the elements of its landscape, and suggesting steps which can still be taken by local authorities to preserve the amenities of their districts. He treats each area in turn, explains the meaning of local names, glances rapidly at its history, and gives census figures to illustrate its recent development. This plan has certain disadvantages, for it entails some repetition and the allocation, for the sake of comprehensiveness, of a good deal of his space to districts where there is now little or no "countryside" to be saved. He has, inevitably, hard things to say of jerry-builders, blatant advertisers, and similar offenders, but his denunciations lose much of their effect by continual repetition.

Despite these drawbacks, it is to be hoped that his book will be as widely read as it deserves, and will in some measure promote the cause which its author has at heart, though, unfortunately, relatively small areas of recreation and pleasure grounds can never retain the real characteristics of true countryside, even if the project of the "green belt" is realized. (The author, incidentally, though making many references to this scheme, nowhere deals with it in detail.) Considerable research, the results of which are agreeably presented, has gone to the making of this book, and its picture of old Middlesex will surprise readers to whom the county is scarcely more than an overgrown dormitory of London. The bibliographies of local topography also add to its value, as do the many black-and-white sketches, which will in time acquire an antiquarian interest.

There are one or two statements in the text which require amendment, for example, the reference to Byron's grave in Harrow churchyard. The derivation of Perivale from pear tree seems far fetched: it is more probably a corruption of Parva from its former name, Greenford Parva. The recent discovery of the remains of a Roman British pile dwelling at Brentford might have been mentioned, as it has some bearing upon the stakes which have been used as evidence of Caesar's crossing of the Thames at that point. G. R. C.

VOYAGES AUX ILES FÉROË. By JEAN CHARCOT. *Paris: Société d'Editions Géographiques . . .* 1934. 7×5 *inches;* 96 *pages; illustrations and map*

Dr. Charcot has sailed to many wilder and more distant islands than the Faroes, but it is clear that none has attracted him so much. When, in 1901, he first visited this lonely archipelago he was so much impressed by its "magnifiques pyramides basaltiques," the tall cliffs and steep grassy hills; so much delighted by its finely made, gaily costumed people who live by fishing and by herding their scraggy sheep without the aid of dogs, that again and again he has returned to them. His book consists of pages written thirty-three years ago supplemented by more recent passages; so the enthusiasm of first impressions is balanced by the authoritative statements of the student.

Dr. Charcot gives a brief history of the islands which goes back to missionaries contemporary with Columbus, and to the Norman pirates of the ninth century who used to re-victual their ships with Faroe sheep. Since 1380 the islands have belonged to Denmark, but the islanders have remained as independent of

the outside world as of their stormy climate, speaking their own Norse language, marrying among themselves.

Finally, it is encouraging to learn that it would be difficult to spell Faroe wrongly, for nine variations are permissible. J. M. S.

A WAYFARER IN BELGIUM. By FLETCHER ALLEN. *London: Methuen & Co.* 1934. $7\frac{1}{2} \times 5$ *inches;* x+208 *pages; illustrations and sketch-map.* 7*s* 6*d*

This is a straightforward book which introduces the reader and traveller, without preliminaries, to the delights of Belgium. The few digressions show that the author knows the people well and has a kindly eye for odd types, and his extracts from early guide-books are amusing. For the rest we have businesslike descriptions of the various towns and pleasure resorts. The author has more than a tourist's knowledge of the Ardennes and the valley of the Meuse, but there is unfortunately not much practical instruction for walkers, which is a pity, since the district, at least in parts, is a walker's paradise. The illustrations are excellent. M. L.

THINGS SEEN IN THE CHÂTEAUX COUNTRY. By Captain LESLIE RICHARDSON. *London: Seeley Service & Co* [1934]. 6×4 *inches;* 156 *pages; illustrations and sketch-map.* 3*s* 6*d*

The latest addition to the "Things Seen" series is as compact and useful as many of its predecessors. An introductory chapter deals with the charms of the Loire, and the river is then followed from Orleans to Nantes, so that some part of the book at least is outside the Châteaux country. Excursions are suggested in the valleys of the Vienne, the Indre, and the Cher. Within his limits the author discourses pleasantly and practically about a district which is well known but always seems to offer something new. The book is well and lavishly illustrated, but travellers will need something better in the way of maps. M. L.

ASIA

THE GEOLOGY OF BURMA. By H. L. CHHIBBER; with contributions by R. RAMAMIRTHAM. *London: Macmillan and Co.* 1934. $9 \times 5\frac{1}{2}$ *inches;* xxviii+538 *pages; illustrations and maps.* 30*s*

THE MINERAL RESOURCES OF BURMA. By H. L. CHHIBBER. *London: Macmillan and Co.* 1934. $9 \times 5\frac{1}{2}$ *inches;* xvi+320 *pages; illustrations and maps.* 18*s*

These two volumes form a very useful compendium on the geology and related subjects of Burma. They are written by a man who knows much of the country, and they form a very good source for general information. They are well produced and the illustrations are good. On the other hand they are expensive, and few private people will find a place for them in their libraries. As in all such works, the personal knowledge of the author cannot cover all the matter he has to write about, and so, to some extent, the treatment of the material varies.

As the two volumes are primarily geological, the geographer will read them only as references—but he will find them very useful in this respect, because the treatment is clear and the material is eminently readable. Further, each main chapter is followed by a comprehensive list of papers and detailed references. But the chief interest of the physical geographer is in the early part of the first volume. The author there gives a concise account of the main physiographical features of Burma, and even if the rather general treatment leaves the specialist wishing for more, the chapters give a wealth of new examples of certain phenomena that any teacher will welcome. As this part is of direct

interest to readers of this *Journal* a list of chapter headings and pages will best indicate its scope. Physical Features (10 pp.), River Systems (17 pp.), Lakes (10 pp.), Earthquakes (24 pp.), Hot Springs (9 pp.), Mud Volcanoes (8 pp.), Denudation (5 pp.), Limestone Caves (9 pp.), Coastline (9 pp.). Much of the remainder of the volume is devoted to stratigraphy, which is treated in the usual way under systems. The section on the igneous activity is full, and its relation to tectonics stressed. The volume closes with a useful chapter on the geotectonics of Burma.

The second volume is, even more than the first, a reference work. All the minerals known to occur in the country are described and their modes of occurrence, how they are worked, and so on, discussed. Soils and water supplies are also treated. As in the earlier volume, full references are given. The reader will also find the historical accounts of the working of certain minerals of considerable interest.

Dr. Chhibber has certainly accomplished a sound piece of work in writing these two volumes, which are likely to remain for a considerable time the standard works on Burmese geology. J. A. S.

A DESERT JOURNAL: Letters from Central Asia. By EVANGELINE FRENCH, MILDRED CABLE, FRANCESCA FRENCH. *London: Constable & Co.* 1934. $7\frac{1}{2} \times 5$ *inches;* x+262 *pages; illustrations and map.* 7*s* 6*d*

The three authors have spent a combined span of ninety-eight years in the service of the China Inland Mission. The present volume deals with their travels in western Kansu, and northern and eastern Sinkiang, beyond the ethnological border of China proper. An idea of the remoteness of the area can be gained from the statement that "The centre of Asia can be reached by four main roads, the simplest and least expensive of which is by the Trans-Siberian Railway, *via* Moscow to Omsk. Thence by river steamer up the Irtish to Lake Zaisan, followed by a five-days' drive in a tarantass to Chuguchak, where Chinese carts can be hired for the three-months' journey across Turkestan and the Gobi Desert to our final destination at Suchow, Kansu, in North-West China."

Explorers prepare expeditions with elaborate care, and yet their dumps of supplies are looted by bandit generals; but these three English ladies in the normal course of their missionary duties think little of starting off on a preaching tour of many months with only a light cart and a hired waggon, along the Gobi Road and away off it to visit isolated fortress-farms in distant oases, or up the wild valleys of the Richthofen Mountains to reach Tibetan lamaseries. In little flashes we see them scrambling out of their wrecked cart, its axle broken, in the midst of a howling Gobi blizzard; we see one of them, stricken with cholera, lying ". . . where the landlord had allowed us to pitch our tent in a small enclosure where he fed his pigs and fowls. It was a dirty, unhealthy hole with a pool of stinking water, but it was not accessible to the public and afforded us a measure of privacy for the few hours when the illness was at its most acute stage." We see them arriving, hot, dusty and tired after days of trekking, at some oasis-village, immediately to be surrounded and pressed upon by crowds of folk curious to hear what they have to say. ("Their mouths drip with Chinese idiom," remark the listeners.) They have no privacy and little rest. But these troubles are but touched upon as mere incidentals in their daily lives. The Moslem rising dominates the political background, towns are destroyed, rebel armies march to and fro, looting and killing, terrified people take refuge in the mountains, there to starve or freeze, bandits lurk on every road seizing transport and food; yet across the foreground the little missionary cart moves on its way unharmed and only occasionally molested.

There are meetings on the road, encounters with old friends met a thousand miles back along the same road, with Mongols, Chinese, soldiers, bandits and lamas. All have something interesting to say. There are visits to the homes of princes and peasants "when after tea and bread is served and the civilities exchanged, they often nod to each other and say 'Aren't they dears!' In their home it is just the same as here, there are real sisters and friends like sisters. It must be so all over the world!" Yes. That is just what one is thinking as one reads.

This is a delightful book. It gives a wonderfully clear picture of Central Asia as it, unfortunately, is at present. The authors are keen observers and record things of wide interest without embellishment. The publishers are to be congratulated on producing what is, alas! uncommon in a book of travel: a large accessible map which can be opened to its fullest extent or refolded in an instant with a single motion of two fingers. The photographs too are good, though after reading the book one cannot but regret that there is no picture of these remarkable ladies themselves. R. A. B.

AFRICA

TRIANGULATION DU CONGO ORIENTAL. By J. MAURY. *Bruxelles: M. Hayez* 1934. 11½×9 *inches;* 176 *pages; maps*

The undertaking which is so ably discussed in this publication can best be described as a large triangulation compilation. The Belgian Congo has found itself confronted with a mass of triangulation of different types, carried out in different epochs since the beginning of the present century, of varying degrees of accuracy and in many cases mutually conflicting. The formidable task of correlating all these sources of information has been undertaken in Brussels by Mons. Maury, and his results, the considerations which led up to them, and the means by which they have been achieved are published in the book under review.

Some idea of the geodetic "pot-pourri" in this part of Africa may be gathered from the fact that it contained samples of the work of the German-Congo Geographical Commission of 1900, the Anglo-Congo Mission of 1907, the Belgian Congo section of the Arc of the Thirtieth Meridian, the Anglo-German-Belgian Mission of 1910, the Anglo-Belgian Mission in Ruanda-Urundi in 1923, and other less important undertakings. The general outline of the adjustment consisted in the establishment of a main backbone of triangulation, based on the completed section of the Meridian Arc, throughout the area, to which backbone closed circuits of other triangulation were adjusted. The author is at pains to analyse the value and reliability of each of the components which were to be welded into a harmonious whole and to make each step and the reasoning for it abundantly clear.

The consideration of the work which is involved brings home two points very clearly. The first is the vast amount of work which is entailed in trying to reconcile a large number of independent surveys of this character and the saving of time and money which would have accrued had a thoroughly sound backbone been observed in the first place prior to the scattering of a large number of disconnected ribs about the country: a counsel of perfection perhaps, but also a lesson which one day we may hope the financial authorities of this and other countries will absorb. The second point is the increased sense of frustration that is felt at the closing down, for financial reasons, of Major Hotine's work on the Meridian Arc in Tanganyika, when it was so near to linking up with the Ruanda–Urundi section.

The book is clearly printed and the diagrams are adequate. M. Maury may well be congratulated on the results of his labours. J. C. T. W.

L'AFRIQUE NOIRE, précédée d'une vue d'ensemble sur le Continent Africain. By JACQUES WEULERSSE. *Paris: A. Fayard & Cie* 1934. 9×5½ *inches;* 484 *pages; diagrams and maps.* 25 *fr*

M. Weulersse has written a lively and informative book, which will be useful as an up-to-date summary of African affairs. His style is clear, and his material handled skilfully, while personal experience of many of the regions he describes imparts a freshness to his pages which is not usually to be found in the ordinary text-book. As is indicated by the title, his work falls into two sections: the first sketches broadly the main outlines of African geography, particularly in relation to its history and to the spread of European influence. The second describes in much greater detail that part of the continent lying south of approximately a line separating the Sahara from the Sudan, and the Nile watershed from the Congo.

The question arises whether the term "Afrique noire," in contrast to the "Afrique blanche," that is mainly Mediterranean Africa, can fittingly be applied to this division, since it includes, in the Union of South Africa, the largest white settlement on the continent, as well as the areas of white settlement in East Africa. This division, well founded structurally and climatically, can also be justified in regard to the indigenous peoples, and it appears that the author regards the colonists as intruders; but in an appreciation of modern Africa, this attitude should surely be abandoned.

The four main divisions he adopts are West, Central (including East) and South Africa, and "L'Afrique indienne." After a general description of each area, he describes each political unit in turn, with emphasis upon economics, population, and administrative system. He takes a pessimistic view of the future of the segregation policy in South Africa, but it is only fair to add that he makes candid comments upon French policy in Central Africa. Without committing himself to the possibility of a rejuvenated African (that is, indigenous) civilization, he believes that in West Africa the signs of such an evolution may be discerned, an evolution which it is the privilege of European nations to foster. The interest of his book lies largely in the presentation of this point of view.

G. R. C.

THE GREAT PYRAMID, IN FACT AND IN THEORY. By WILLIAM KINGSLAND. Part II. Theory. *London: Rider & Co.* 1935. 10×7½ *inches;* xii+140 *pages; illustrations and plans.* 15*s*

The first part of this work was reviewed in the *Journal*, vol. 82, p. 463. In this part the author examines the theories of four different groups of Pyramid speculators and the conclusions of the archaeologists, and rejects them all in favour of his own theory. This is that the Pyramid was constructed "for some purpose which they do not see fit to disclose to the world at large" (p. 132) either by or under the directions of the "Hierarchy of Initiates." These gentlemen are apparently a sort of super secret society lying behind and directing such activities as the Ancient Mysteries, Rosicrucianism, and Theosophy, and guiding "as far as is possible the Evolution of Humanity" (p. 103). The author suggests as a possible solution of the mystery that the purpose was to provide secret chambers for initiation ceremonies. The whole is supported on a vast structure of impervious inaccuracy, the nature of which has been to some extent indicated in the review of Part I.

One sighs for the pen of a De Morgan to deal really properly with this sort of book. In the pages of his 'Budget of Paradoxes' are several of Mr. Kingsland's "authorities." Let him turn to vol. 1, pp. 256 ff. of Dr. Eugene Smith's edition of that work for De Morgan's remarks on S. A. Mackey. Two minutes with the

D.N.B. would have shown Mr. Kingsland that John Greaves lived in the seventeenth, not the eighteenth, century, and 'Pyramidographia' was published in 1646, not 1736. C. A. E.

CENTRAL AND SOUTH AMERICA

ERGEBNISSE GEOLOGISCHER FORSCHUNGEN IN MINAS Geraes (Brasilien). By B. VON FREYBERG. (Sonder-Ausgabe des Neuen Jahrbuchs für Mineralogie, Geologie und Paläontologie, Sonderband II.) *Stuttgart: E. Schweizerbart* 1932. 9½×6 *inches;* xii+404 *pages; illustrations and maps. M.*52

DIE BODENSCHÄTZE DES STAATES MINAS GERAES (BRASILIEN). By B. VON FREYBERG. *Stuttgart: E. Schweizerbart* 1934. 10×6½ *inches;* 453 *pages; illustrations and maps. M.*54

The State of Minas Geraes comprising an area nearly twice that of the British Isles, very little of which is served by railways, is complex in geological structure and rich in mineral resources, affording the serious geologist abundant scope for original work. Professor von Freyberg has checked over previous researches in this field and has collected in his two books such data as are at present available for the geology and mineral resources of the State. Both works are of the learned and scientific form, of interest chiefly, though not exclusively, to professional geologists and mining experts.

Throughout the eastern and south-eastern parts of Minas Geraes basal crystalline rocks (Kristallines Grundgebirge) appear at the surface over wide areas. To these Professor von Freyberg devotes only passing reference. He is chiefly concerned in his geological treatise with the four stratified groups which are recognized in the central and western parts—the Minas, Itacolumy, Bambuhy, and Gondwana series—and especially with the mineralized Minas series, which he has for obvious reasons examined most fully. Later sections of this first book deal with such topics as the influence of tectonic movements on the drainage system and the relations between geological structure and the scenic landscape. A bibliographical index of 976 references is appended. In his work on the mineral deposits of Minas Geraes, Professor von Freyberg passes after a preliminary chapter on geology and climate to detailed accounts of the occurrence, the economic value, and the exploitation of all the minerals known in the area. Here we have a comprehensive work of reference, but one which the author himself would admit is by no means complete, for, as he observes, the investigation of the iron ore deposits alone would demand more than a life-time of labour. Of special interest in this volume are the historical sketches of mining activities and the accounts given of present-day economic conditions under which minerals are worked or left for future development; a good illustration in point is furnished by the section on iron ores (pp. 185–242).

The reader's first thought is surprise that so much can be written on one out-of-the-way section of one distant country. He realizes later that, even so, comparatively little has been discovered of what is to be known of that area, and he cannot but admire the author's patient labour and scientific enthusiasm.

E. W. S.

SOLOLÁ: A Guatemalan Town and Cakchiquel Market-Center. By WEBSTER MCBRIDE. *Department of Middle American Research, Tulane University, New Orleans, U.S.A.* 1933. 10½×8 *inches;* 152 *pages; illustrations and maps*

The little volume under review is one of the valuable series of pamphlets issued under the auspices of the Department of Middle American Research of Tulane,

the Louisiana University which, qualified both by its geographical situation and modern equipment for ethnographic exploration, has recently done so much by field work as well as study to shed light upon Central American problems.

'Sololá' deals with a special field study made by Mr. McBride in March and April of 1932, in the region which those who, like the present reviewer, have visited the Atitlan neighbourhood recently, recall as a town attained by a very beautiful if narrow and steeply graded road, rising 5000 feet in 5 miles and enlivened by hair-pin bends and overhanging precipices. Mr. McBride's object was an intensive study of the market of Sololá, the ancient town which on Fridays draws vendors from eighteen surrounding *pueblos* for a market in which the author counted one Friday eleven thousand sellers and buyers. The town stands on the north margin of a volcanic region running from South Mexico to Panama, where many of the volcanoes, more than a hundred in number, still not infrequently display their inner activity; nearly all these volcanic regions are of great fertility. North of Sololá begins the immense "cold" plateau running up to the Mexican border, where one may sometimes ride for hours without encountering a village; to the near south lie "temperate" lands producing wheat and other cereals, potatoes and root crops of great variety, and forming rich grazing grounds for sheep; still farther south come the "hot" lowlands streaming to the coast, growing cotton, cacao, bananas, coconuts, pineapples, and quantities of other tropical fruits. Thus the market of Sololá, where sellers are grouped according to class of products, is reminiscent of the Moorish *suk*, as indispensable in an equally shopless region. One must however beware of drawing inferences from comparisons; in this, as in certain other districts of Guatemala, the reviewer has noted the woven sandals and straw or grass rain-coats used by country folk and making a common trap for visitors who seek to connect Nippon with Central America; as a matter of fact, the Japanese were the tutors of the native folk of Mexico in the manufacture of these articles—but this was in historical times, the first Japanese embassies having visited Mexico as early as 1610 and 1614.

Mr. McBride is chiefly concerned with the Sololá market and the light it throws on Cakchiquel life; but in the course of his study he writes on the history of these interesting folk, on ethnology, topography, botany, climate, and horticulture. The Cakchiquel, as he remarks, are skilful horticulturists by old tradition, terracing their little gardens and irrigating their crops with unremitting care; and it is interesting to note that tribal rules of conduct are still strong enough for the inhabitants of Nahualá and Ixtahuacan to continue to exclude intoxicating liquor from the district and to maintain the old status of communities where whites may not reside.

Trading among the folk of Mexico and Guatemala is no recent development, as Mr. McBride points out. Four hundred years ago, before the Spanish Conquest, routes were marked out from Mexico city to Central America and followed regularly by the Nahuatl guild of traders known as *puchteca;* months or even years were sometimes spent upon these trading journeys. So that it is not surprising to find patient Cakchiquel carriers travelling for many days from the coasts to bring roast alligator and dried shrimp to a market situated 8000 feet up in the hills, or vendors of *remedios* bringing potent roots and seeds from the tangled forests of the river valleys after months of collecting work.

The author's sketch-maps are clear and good; the bibliography, though too brief, is useful, and the index adequate. The sans-serif type does not lend itself to comfortable reading however, and the photographs, originally excellent, are so poorly reproduced as to be disappointing. L. E. J.

AUSTRALASIA AND PACIFIC

THE VOYAGE OF THOMAS BEST TO THE EAST INDIES, 1612–14. Edited by Sir WILLIAM FOSTER. (Works issued by the Hakluyt Society. Second Series. No. LXXV. Issued for 1934.) *London* 1934. 9×5½ *inches;* lvi+316 *pages; maps*

In this volume Sir William Foster carries one stage farther his elucidation of the early history of English relations with the East. The voyage of Thomas Best, usually referred to as the Tenth Voyage of the East India Company, is important in the development of trade with the Malay archipelago. The object was to initiate a triangular exchange similar to that which formed the basis of trans-Atlantic commerce: English cloth was to be traded at Surat for calico which was then to be carried to the archipelago, there to be bartered for pepper and other Oriental products. The Court Minutes of the Company, treating of this voyage, are lost, but Sir William prints a collection of narratives by various members, which enable its course to be followed in considerable detail. The chief of these are Best's Journal and the joint narrative of Standish the surgeon and Croft the purser.

Though the voyage was not without its critical moments, it was on the whole a success. Best was successful in beating off the persistent attacks of a Portuguese squadron and in founding a factory at Surat. A Portuguese account of the naval engagements is given which shows that the English success was due not to their heroism alone, but largely to the shortcomings of their rivals' equipment. At Tiku and Bantam, where another factory was established, a cargo of pepper was loaded, and the voyage finally yielded the satisfactory return of 148 per cent. on the outlay.

Best's journal is often little more than a log, concise and seamanlike, but it conveys the atmosphere of the voyage by its matter-of-fact style. Croft and Standish are more expansive, and the former describes the fight against the Portuguese with real eloquence. In the editor's lucid introduction the reader will meet many entertaining personages—a chaplain accused, wrongly it appears, of "disanimating" his charges at a critical moment, the "black boy," first of his nation to be admitted to the Church of England, and the musician who, performing on the virginals before Jahangir, was so discouraged by the Emperor's lack of appreciation that he "dyed with conceiptt." It is scarcely necessary to add that a mass of relevant information is set out in the numerous footnotes.

G. R. C.

THE PASTORAL INDUSTRIES OF NEW ZEALAND. By R. OGILVIE BUCHANAN. (The Institute of British Geographers. Publication No. 2 [in front of which is bound No. 1, entitled 'Transactions' and consisting of pp. v–ix].) *London: George Philip & Son* 1935. 10×7 *inches;* xiii–xv+100 *pages; maps and diagrams.* 7*s* 6*d*

This publication contains the first statement of the aims and activities of the Institute of British Geographers which was constituted in 1933 to serve as a medium for cooperation and discussion among "academic geographers," that is, in the main, members of the schools of geography in the Universities of the British Isles. It will facilitate the reading and full discussion of papers, and visits to "localities offering opportunities for work in the field." It is apparent from the list of papers already read that educational and scientific methods are to receive as much attention as the results of research. It may also be gathered from the essay which appears as Publication No. 2 that the intention is to publish researches which from length or for other reasons are not suited to the pages of existing journals devoted to geography.

Mr. Buchanan, with the advantage of personal acquaintance with the country, has assembled a great mass of detailed information on the sheep and dairying industries of New Zealand, which he presents clearly, but for occasional lapses into a technical jargon. In some respects his study covers more ground than might be expected from the title, for these industries form so predominant a part of New Zealand's economic life, that there are few aspects of it upon which he does not touch. He is at pains to excuse the extent to which economic discussions figure in his pages, claiming that "the nature and extent of the influence of the geographical conditions are themselves dependent on the precise nature of the economic conditions." This appears rather to be arguing in a circle, for in New Zealand the economic conditions arise almost entirely from the geographical.

The plan of the work follows a logical pattern, the present state of the industries being set against the physical and historical background. The distributions do not show striking divergence from what would be anticipated; as the author shows, the critical factor dividing dairy-farming from sheep-raising is relief modified by soil. He brings out clearly the importance of small variations within a fairly uniform régime, and the advantages which man has derived from them. The cooperative system is favoured by the existence of one large wholesale market for butter, and this in turn is due to New Zealand's world position and her special relationship with Great Britain. The ability to compete in the market thus provided is strengthened by factors such as the equable annual temperature, and the reliability of the spring rainfall.

It is to be regretted that the statistical tables have not been brought up to date, and the interested reader saved from reference to the official Year-book. This might have been done without necessarily imposing the obligation of discussing the interesting tendencies they reveal. The somewhat pessimistic character of the author's concluding remarks is not altogether justified. The export of butter for 1932 showed an increase of 16 per cent. over the figures for 1930, though it is true that the average value had fallen more than twenty-eight shillings a hundredweight. It would also have assisted the general reader if more direct comparisons had been made between the New Zealand figures and those of other producing countries. G. R. C.

POLAR REGIONS

THE POLAR REGIONS: an Anthology of Arctic and Antarctic Photographs. Edited by J. M. Scott. (Life and Art in Photograph. II.) *London: Chatto and Windus* [1934]. 10×7½ *inches; 100 pages; illustrations.* 5*s*

'The Polar Regions' contains a hundred pages of beautifully reproduced photographs, prefaced with a short introduction by the editor. Mr. Scott introduces his subject in conversational style for the unscientific reader. His trend of thought follows the order in which the photographs are placed, and he talks briefly of the physical and meteorological conditions of the Polar regions, their fauna and flora and Eskimo life, giving a short résumé of the history of their exploration both past and present, and finally discussing their economic activities.

As an artistic production alone the book is well worth possessing. Photographically it shows skill of treatment and variety of subject, ranging from impressive views of mountains and icebergs, to detailed photographs of saxifrage and ice flowers, but one feels, with the editor, that it is a "great loss that these photographs can convey no idea of colour contrasts, of whites and blues and blacks, nor of the more subtle shades when the sun hangs low above a clear horizon, or, as in winter, when skies are decorated with the flood-lit, shot-silk curtains of the northern lights."

The photographs have the merit of commending themselves both to the popular and to the scientific mind. To the geomorphologist they are of unique interest. Practically every stage in the formation and decay of sea-ice is represented; there is an unusually fine photograph of a hanging glacier, a phenomenon so often left to the imagination of the student; there is also a remarkable illustration of strata at a high dip, apparently bedded unconformably upon strata at a lower inclination, and intersected by a perpendicular normal fault along which there has been differential slipping of corresponding beds, the whole thing outlined by snow resting on projecting edges. It should be remembered that ice action on a scale comparable to that of the Quaternary Glaciation of Europe and America is merely a text-book phenomenon to all but the Polar explorer. This collection of photographs provides therefore a much-needed pictorial supplement, at a reasonable price, to the standard works on glaciology. J. A. C.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

THE CHANGING WORLD OF THE ICE AGE. By REGINALD ALDWORTH DALY. *New Haven: Yale University Press; London: Humphrey Milford* 1934. $9^1/_2 \times 6$ *inches;* xx+272 *pages; illustrations and maps.* $5.00 (22*s* 6*d*)

After an introductory chapter upon ice-caps past and present the author deals with the retreat of the Fennoscandian and North American ice-sheets and the accompanying phenomena. In his treatment of these matters he lays special stress upon those points that bear upon changes of level in land and sea; and in the subsequent chapters, which form more than half the book, he discusses at length the way these changes have been brought about. An ice-sheet presses down the part of the crust on which it rests, and the author distinguishes between the immediate response, due to the elasticity of the material of the crust, and a delayed response, due to the flow of the magma beneath. It has long been recognized that the weight of an ice-sheet causes depression, and that when the ice melts the land will rise again; but in one respect the author differs from his predecessors. He thinks that there was not merely bending but actual fracture at the borders of the ice-sheet. This is his "punching" hypothesis by which he seeks to explain the fact that old lake and sea terraces are now level up to the edge of the old ice-sheet but rise towards its interior.

Though an ice-sheet depresses the land upon which it rests, the water that forms the ice must have been withdrawn from the ocean and therefore the level of the ocean falls. Consequently in regions far from the ice-sheet there is an apparent rise of the land. According to Molengraaf (*Geogr. J.*, vol. 57, p. 100), it was during the period of maximum glaciation that the Sunda and Sahul shelves stood at their highest above the sea. This and other instances are described and discussed in the volume under review.

The investigation of the actual changes of level due to the growth and decay of ice-sheets is greatly complicated by warping of the crust due to other causes. Daly fully recognizes the difficulties and makes a brave attempt to disentangle the effects. He devotes one chapter to high sea-levels of the Pleistocene period and another to low sea-levels of the same period.

In his last chapter he expounds his "glacial control" theory of coral reefs. During the period of maximum glaciation, when tropical seas were at a low level, banks and shelves then existing about this level were smoothed by wave-action. When the sea rose again corals grew most freely upon their outward edges. In this way he accounts for the remarkable uniformity in depth of so many lagoons.

But the reader must refer to the book itself for a full discussion. He will find it interesting and suggestive throughout and there are 149 well-drawn illustrations to help him to follow the text. P. L.

CARTOGRAPHY

WIE FINDET UND ZEICHNET MAN GRADNETZE VON LAND und Sternkarten? By GEORG SCHEFFERS. (Mathematisch-Physikalische Bibliothek Reihe I. 85/86.) *Leipzig: B. G. Teubner* 1934. 7×4½ *inches;* [vi+]98 *pages; diagrams*

In this little handbook the author sets out, as his title implies, to show how to draw the graticules of the various maps whose projections he considers. He is not therefore concerned with the equations of the projections, and though a certain amount of mathematics is necessary for his purpose, yet he concerns himself as far as possible with the geometrical constructions of the parallels and meridians, rather than with the trigonometrical calculations of their positions and sizes.

The book seems very incomplete, perhaps because such constructions—without more trigonometry—are only possible in a limited number of cases. The author deals mainly with maps of the whole world or hemispheres and divides his projections into Equal Area, Conformal, and Perspective groups, closing with a discussion of an oblique map of the Celestial Sphere. The Sinusoidal, Bonne's, and Lambert's (or Alber's) Equal Area with two standard parallels are dealt with fully, but of such common projections as the Simple Conic and Cassini's there is no mention; and though Mercator's famous map receives good attention, there is no indication of the transverse case, Gauss's Conformal, the Conical Orthomorphic (Lambert's Second), or the interesting Polyconics. In the Perspective section the author constructs the Stereographic (Normal and Transverse) and the transverse gnomonic, both on the tangent plane, but is obviously unable by geometry alone to bring in the Minimum Error varieties.

As may be imagined from the general plan, each map is considered individually, and there are no general relations given, such as the conditions for an equal area or conformal projection; and while in dealing with Mercator the author deduces the relation $dh = d\beta \sec \beta$, yet he does not progress further to the integral $h = \log \tan (\pi/4 - \beta/2)$, for the distance from the Equator of the parallel of latitude β, but gives instead a geometrical construction for it. The constructions themselves are very interesting and indicate in the author considerable ingenuity and geometrical power, but they tend generally to be intricate, and many of the figures seem rather to confuse the student than otherwise by the multiplicity of lines upon them, though they certainly show what the complete constructions of the graticules require. R. K. M.

THE NATIONAL PLANS (the Ten-foot, Five-foot, Twenty-five-inch, and Six-inch scales). By Brigadier H. St. J. L. WINTERBOTHAM, C.M.G., D.S.O., A.D.C., Director-General of the Ordnance Survey 1934. (Ordnance Survey Professional Papers New Series No. 16.) *London: His Majesty's Stationery Office* 1934. 11×8½ *inches;* 106 *pages; appendix, illustrations and diagrams.* 4*s* 6*d*

The contents of this absorbingly interesting Professional Paper of the Ordnance Survey are more or less summarized in the Appendix which, in the form of a diagram, sets forth seriatim all the many processes which go to the making of a revised 1/2500 plan and of a 6-inch reduction therefrom. This diagram is drawn to represent a pipe into which flow from the various sources the component processes of 1/2500 revision and out of which eventually appear the finished plan at 25 inches to the mile, and also the 6-inch map.

The text of the professional paper deals in detail with all these processes and is in fact far more than just a history of the National Plans. Chapters are devoted

to the individual items of Areas, Boundaries, Names and Levels which are such features of the Ordnance Survey large-scale plan, and a most interesting chapter is given to the seemingly unimportant but actually vital question of paper and ink. The subject of air revision has but a paltry two-page chapter and one could have wished for a great deal more. Perhaps in some future edition that section may be expanded. Readers of the remainder of the book will however soon see that revision is not just survey and that the mapping of "existing and visible detail" really only occupies a small proportion of the time required to revise a plan. Names, areas, boundaries, levels and drawing are lengthy processes and none of these are helped in the least by air photography.

The illustrations throughout are excellent, well chosen, and of more than usual interest. The contrast between a 1/1056 plan specially drawn for that scale and a 1/2500 enlarged photographically to 1/1250 is well brought out by Plate 5 and the crudity of enlarged work is most apparent. Plate 6 shows somewhat arrestingly the changes that take place in a plan in the short space of eighteen years, and one feels that probably had it been so desired an excerpt completely blank could easily have been chosen for the 1914 example. This problem of facing extensive change with a revision staff gravely reduced in 1922 forms the theme of the later chapters of the book. Graph No. 4 which faces p. 88 gives the picture in all its gloomy bareness and it is a graph which every one who knows our National Map and is proud of it should examine. In 1923 the Ordnance Survey was giving an annual output of just over 2000 revised plans every year. The total number of plans in England, Wales, and Scotland is about 52,000. Thus in 1923 the average cycle for a plan to be revised was approximately twenty-six years. Then, owing to reductions in staff, annual output has, according to the graph, fallen steadily to the lamentable figure of 500 revised plans per annum. Dividing this output figure into 50,000 it is apparent that our national plans are now on a hundred-year cycle as regards revision! Such a state of affairs is a national disgrace, but only increased staff can rectify it. The circle is vicious for, as Section 26 points out clearly, the more out of date the national plans become the longer does one plan take to revise. Graph No. 5 opposite p. 90 gives numerical values for this and shows that from 10 man/days per plan in 1923 we have reached nearly 80 man/days ten years later and the curve is a hyperbolic one; ". . . the facts are that we have to-day no 'open' (easy rural scenery) plans to do, and that our plans are not only 'close' but so much so as far to surpass the work labelled 'close' during the first and second revisions . . ." is a quotation from Section 26 and obviously represents the state of affairs in England to-day.

Apart from ordinary revision of 1/2500 plans the work of the Ordnance Survey in connection with special surveys for Land Registration (Chapter 22), Tithe Redemption (Chapter 24), and with the mapping of Antiquities (Chapter 25) is shortly described. This latter subject is an extensive one in itself and the section dealing with it is naturally but a résumé. Professional Paper No. 16 is indeed a mine of information as regards the whole functioning of the Ordnance Survey and should be read with profit by the layman as well as by those technically interested. It is a pity that it is only published in paper covers. P. K. B.

ECONOMIC AND HISTORICAL GEOGRAPHY

PROBLÈMES ÉCONOMIQUES DE L'HEURE PRÉSENTE: conférences données à l'École des Hautes Études Commerciales de Montréal . . . By LUCIEN ROMIER. *Montréal: Albert Lévesque* (1932) $7\frac{1}{2}\times5$ *inches;* 318 *pages.* $1.00

The course of lectures reproduced in this little book were delivered by M.

Romier at the École des Hautes Études Commerciales de Montréal in the autumn of 1932. The book itself is divided into two parts which are closely connected—"Les Méthodes Économiques de l'Europe," and "La Crise du Capitalisme"—and their subject is the present economic depression. M. Romier's thesis is briefly this. Since the War the joint-stock company financed by the banks has replaced the individual producer—a fact more true of France than of either Britain or Germany. As a result there has been a great increase in production, an increase which is progressive as part of the profits is usually devoted to an extension of the industrial establishments concerned. Over-production ensues, but the price of the commodity remains high, partly because of over-capitalization, and partly because the cost of distribution has not been reduced. As a remedy he suggests that the industrialists should reduce their capital by, say, one-third, that the wage-earners should submit to a slight reduction of their wages, and that the cost of distribution should be reduced. M. Romier's argument in favour of these changes is however too long to reproduce here and, to be candid, is not wholly convincing.

The chapters which will most appeal to geographers are probably those dealing with some characteristics of European commerce and the situation in Russia. The author thinks that the most striking feature of European civilization has been *l'expansionnisme*. This he attributes in part to the physical features of the Continent which led to the growth of nationalism and gave easy access to the sea, and in part to the spread of Christianity. The European, he says, is an *évangélisateur*, and this applies whether he is or is not a believer. In fact he regards European peoples as inspired by motives somewhat similar to those of the Elizabethan seamen who set out to attack Spanish treasure ships "for the glory of God and the commodity of the country." In the chapter on Russia M. Romier draws attention to one fact which is of special interest at the present time. Notwithstanding the size of the Russian army it could not be used for invasion as the transport system is so defective. On the other hand the development of industries and railways during the next ten years would make it a formidable factor in European politics. J. McF.

LA GÉOGRAPHIE HUMAINE. By JEAN BRUNHES. Fourth Edition; revised by MARIEL JEAN-BRUNHES DELAMARRE and PIERRE DEFFONTAINES. *Paris: Félix Alcan* 1934. 10×6½ *inches*. [Part] I. Les faits essentiels . . . xii+574 *pages*. [Part] II. Monographies; liaisons avec les disciplines voisines. 575–987 *pages*. [Part] III. Illustrations hors texte. 162 *pages and illustrations and maps*. 130 *fr. complete*

The first edition of this well-known work appeared in 1910. Before the author's death in 1930 a third edition, in English, with additional chapters, *e.g.* on the Central Andes by Dr. Isaiah Bowman, had been published in the United States. The present volumes contain all the material in the American edition, a certain number of new sections, and many additional bibliographical notes and illustrations, and have been brought up to date throughout. The editors have striven to bring the book into conformity with the development of the author's ideas during the last years of his life, so that it may be accepted as the definitive edition of his great work. In its widest interpretation, he regarded human geography as "l'étude générale de la surface humanisée de la planète"; but in practice, and for the purpose of this book, he confined it to the fundamental and essential portion of this study, conceiving it to be the task of the "géographie de l'histoire" to demonstrate the influences of these principles upon the historical development of human societies. G. R. C.

GENERAL

LOAFING ROUND THE GLOBE. By RICHARD KATZ. Translated from the German by GERALD GRIFFIN. *London: Hutchinson & Co.* 1935. 9½×6 *inches; 288 pages; illustrations.* 18*s*

"Don't take too many photographs. The impression produced on the brain through the eye is more effective than that produced by the lens on the film." This is one of a series of maxims for "fellow-loafers," written, presumably, from Penang, and with which, for a few moments, Herr Katz allows himself to hold up the course of his story. His photographs, as a whole, are not pictorial counterparts of incidents described, and there is a pleasant feeling of haphazardness about them, but it is a haphazardness seasoned with a certain amount of artistic choice. As a writer, Herr Katz seems to have taken as his motto "observe rather than inform." He is preoccupied with making a direct appeal to his reader's imagination, and the result of this is a style which is admirably adapted to the "travelogue" and fashioned for the "Durchschnittsmensch."

Briefly, his itinerary is as follows: Berlin–Hamburg–Egypt (Helwan, the Pyramids, Khartoum), across to Bombay, from thence to Calcutta by way of Benares, on to Ceylon and Singapore, and thence *via* Sumatra, Java, and Celebes to Australia (Brisbane, Sydney, the Bush), on again past Fiji and Samoa back to New Zealand, then across to Hawaii, back again to Japan (Osaka, Kyoto, Tokyo), and over to China (Peiping, Tsingtau, and Amoy), back again to Yokohama, across to Seattle, down California, across to New York *via* Yosemite Valley and Chicago, down south to Havana, and then home. Herr Katz's send-off from the Old World is an exceptionally rough crossing of the "Bay," while the New World can think of no better parting gift for him than a hurricane at Havana which thoroughly upsets the Americanized "Grossstadt," and delays the boat's sailing for Europe. And between these poles there is a wealth of observation blended with a humour which, in some cases, is light and pungent and quite un-German.

If the hothouse-grown sophisticated society of Helwan distresses Herr Katz for a moment, he seeks solace in attending in the company of three chosen European (German) neophytes a service of the Rifajat sect, with all its attendant thrills and dervish-dancing. Again in India, it is the India of Benares, of the *ghauts* and caste-marks rather than that of Bombay and Calcutta that has a message for Herr Katz. Kyoto with its shrines and temples is more "intimate" than post-earthquake Tokyo with its chaotic street-planning and department-stores; the Bush with its wattle and eucalypti is, we cannot help feeling, preferred to Sydney *en fête* for the visit of thirty American battleships. Yet though Herr Katz is distressed and sometimes alarmed at the gradual Westernization of Japan, he is frankly delighted by a concert given by the Municipal Orchestra of Tokyo, where native executants have had for some considerable time all the advantages of training from German conservatoire professors! Herr Katz's attitude towards the institutions of English and Dutch colonization is that of an open-minded traveller, and one may suspect, here and there, a lurking admiration, but the German cemetery at Tsingtau evokes a lament for past glories, albeit dignified and discreet. Mr. Gerald Griffin's admirable translation will help to make this book a welcome addition to travel literature. C. K. C.

THE MONTHLY RECORD

JUBILEE OF HIS MAJESTY THE KING

The King having signified his pleasure to receive the Addresses of Learned Societies through the Secretary of State for Home Affairs, the following Address on vellum, signed by the President, the Senior Honorary Secretary, and the Foreign Secretary, was on May 4 delivered to the Home Office for submission to His Majesty:

ADDRESS TO HIS MOST GRACIOUS MAJESTY KING GEORGE V ON THE OCCASION OF THE TWENTY-FIFTH ANNIVERSARY OF HIS ACCESSION TO THE THRONE

MAY IT PLEASE YOUR MAJESTY

WE, the President, Council, and Fellows of the Royal Geographical Society humbly beg Your Majesty to accept our most heartfelt congratulations on the happy completion of the Twenty-fifth Year of Your Majesty's reign which will undoubtedly be recorded in the histories of the future as one of the most eventful of any Sovereign of Great Britain.

We venture herewith to convey to Your Majesty an expression of the joy we feel that it has pleased Almighty God to preserve Your life through these disturbed and troublous years and we sincerely hope that He may continue to protect and guide You for many years to come in order that with Your help Great Britain and the several Partners in the British Empire may enjoy the blessings of Peace and Prosperity.

The Royal Geographical Society is proud to remember that Your Majesty has been personally connected with it since 1894 when You became Honorary Vice-President and in 1910 succeeded His Majesty King Edward VII as Patron of the Society. On several occasions You have, moreover, honoured the Society by attending ceremonies arranged by it in memory of distinguished Geographers, and in March 1932 You were pleased to visit the Society's House, accompanied by Her Majesty The Queen, who signified her pleasure by graciously consenting to become a Patron of the Society.

Our Society has a membership of six thousand Fellows, scattered over the world, while as regards the Empire there can scarcely be any part of it which has not some close association, through the enduring names of famous leaders, with Expeditions sent out or supported by the Royal Geographical Society.

The Fellows of the Society, which thus forms a great bond between the different parts of those lands over which Your Majesty reigns, are joined together by a common loyalty to the Throne and to the Person of Your Majesty. We therefore unitedly and humbly beg Your Majesty to accept this Address as an expression of our loyal devotion and we hope that You may long be spared, with our Gracious Queen, to stand at the head of the great British Commonwealth of Nations and to continue to give all Your subjects that example of wisdom and steadfastness which has been such an inspiration to them during the trials and calamities of the last twenty years.

Seal of the Society

A letter from the Home Office dated 9 May 1935 informed the President that the Secretary of State had been commanded by the King to convey His Majesty's thanks for the loyal and dutiful address from the President, Council, and Fellows of the Royal Geographical Society on the completion of the twenty-fifth year of His Majesty's reign, and to assure the Society that His Majesty deeply appreciates the sentiments of loyalty and affection to which it gives expression.

THE STANLEY-LIVINGSTONE MEMORIAL AT UJIJI

Colonel Moulaert, Vice-Gouverneur Général Honoraire du Congo Belge, has recently sent some interesting information to the Society with regard to the meeting-place of Livingstone and Stanley in 1871. In an attempt to verify the traditional site, which was marked by a mango-tree, Colonel Moulaert interviewed Marzuku, who was probably the only survivor of the days of Livingstone in Ujiji: Marzuku's recollection was imperfect, for Stanley met Livingstone at Ujiji in October 1871, and Cameron did not come there until February 1874. But the conversation ran thus:

"Do you remember the arrival of the first white man in Ujiji?"

"Yes, I remember it; I saw him."

"How did the white man arrive here?"

"He came by canoe. He must have come from the other side of the lake."

"How long did he stay here?"

"When he landed the first time he camped near the tree which was at that time the only mango-tree in Ujiji, and he did not stay here more than a day. Then he left for the North towards Urundi, still by canoe. Everywhere he asked the names of the mountains, the rivers, the native chiefs, etc. . . . About two months later he came back, spent another day here and then turned southward. I think that he crossed the lake in order to return to the other bank. Afterwards I learnt that he died near Ubembo, and that before he died, he told his boy Ulaya that when he was dead, they must open his stomach, take out the intestines, and then preserve his body with a preparation that he had already given them, put it into a case and have it sent to Zanzibar: from what I have heard say, this was done."

"Didn't another white man arrive at the same time?"

"About two months after the first white man left for the South, a second white man arrived from Zanzibar, named Cameron: he stayed here five or six days and then left for the other side of the lake. I never heard tell of him afterwards."

"Have you never heard of Stanley?"

"I think so. A third white man arrived here a little later with many soldiers and porters: he came from Zanzibar and left for the North by way of the lake. I think he must have left for the Congo."

Colonel Moulaert also sends a large-scale plan of Ujiji, showing not only the spot where the meeting between Livingstone and Stanley probably took place, but also the variation in the levels of the lake, which has sunk nearly 15 feet since 1871. As will be remembered from an article in the *Journal*, vol. 79, p. 318, a memorial in stone has been erected on the site of the old mango-tree, which has died and been succeeded by four young trees grafted from the old stock.

INTERNAL MIGRATION IN THE UNITED STATES

The Social Science Research Council has organized a 'Study of Population Redistribution' as a contribution to the relief of the depression in the United States. Its object is to determine how far it is desirable or necessary to encourage large movements of population within the States, whether for example it is politic to move people back into areas from which migrations have recently taken place. As the foundation of this work, a monograph on 'Internal Migration in the United States' has been prepared by Professor C. W. Thornthwaite (Univ. of Pennsylvania, 1934). By the use of the information on the "State of birth" in the censuses from 1850 he has been able to show graphically the general amount and direction of inter-State migration of native-born citizens. His study resolves itself into an outline economic history of the country in the last hundred

years as reflected in these figures. The obvious feature is of course the western march of settlement: this continued until 1920, after which it is directed to California only. This progress westwards has definite features of population movement: about three decades after the first settlement of an area, the surplus population available for migration reaches a maximum: in another three decades it has been transformed into a deficit, and the next influence is the industrialization of the area. Thus a second wave follows upon the first pioneering movement: judging from the migration figures, industrial expansion had ceased in Massachusetts about 1900, and had reached Michigan between 1910–20, and Illinois and Indiana in the following decade.

Local conditions introduce variations into this general movement: for example, the southward shift of the textile industry between 1920–30 made North Carolina the one increasing southern State with the exception of Florida. The south-to-north movement of the negro population is perhaps the most important of these subsidiary currents.

A further modification has been introduced in the last few years, which is also sharply reflected in the figures for migration within the individual States. Between 1920 and 1930 several million people left the farms for the large cities, so that the farm population, despite a high rate of vital increase, suffered a net loss of one million. At present there is a drift away from the cities mainly to subsistence farming on marginal lands. In some States the prospects for agriculture are threatened by the increase of soil erosion: for example, in four counties of Oklahoma almost a fourth of the cultivable area has been abandoned on account of erosion. The movement to the country however is probably merely a temporary retreat until conditions improve.

The chief characteristic revealed is the extreme mobility of population, to which the advent of cheap transport and improved communications has largely contributed. The result of this study should at least prevent this mobility from being employed to "place people where they are not likely to stay."

THE NORSE SETTLEMENT OF BRATTAHLID IN GREENLAND

An interesting account of excavations in 1932 of Norse ruins in the Eastern Settlement of Greenland is given by Dr. P. Nørlund and Dr. M. Stenberger in *Meddelelser om Grønland*, vol. 88. Brattahlid, the site examined, lies near the head of Eriksfjord in the Julianehaab district, and was established by Erik the Red, the founder of the colony. The various ruins summarize the history of the Norse settlements. Those of the church, the earliest in Greenland, date from very near A.D. 1100, and traces of an even earlier foundation were discovered beneath. Standing apart from the permanent dwellings, the remains of booths and fireplaces were found, marking the site of a market-place, and very probably of the earliest meeting-place or "Thing place," before its removal to Gadar. This was conveniently placed for the merchants arriving by sea. The dwelling-houses show all stages of development. The original farm, also the oldest in Greenland, close to which stood church and meeting-place, was a large hall-like building, the one room serving all purposes and containing a well within it. It is presumed to be eleventh-century work, and other accommodation was added during the three following centuries.

South of the river a fully developed "passage house" was excavated, with no less than seven rooms in addition to the passage. This type represented the latest development: it may not have been built until the fourteenth century, and was apparently not inhabited for long. This type, which bears a resemblance to Eskimo buildings where a passage was also used to prevent the direct entrance of cold air, was probably of independent Greenland-Icelandic origin. On two

farms carefully built byres with stalls for forty cows were found, protected in a similar fashion from the cold.

The majority of the bones found in the middens belonged to seals, principally the harp seal. This is taken to show that seal-hunting was for the Norsemen a seasonal occupation. Other animals represented were pigs, horses, sheep, oxen, and reindeer. Two finds of iron slag point to the possibility of Norse iron-smelting. No objects of a date definitely later than 1400 were found, nor any which must necessarily have been imported from Europe. The research work was helped considerably by air photographs supplied by Rasmussen's last Thule expedition.

TOPOGRAPHICAL MAPS OF AUSTRALIA

For some years we have received for the Map Collection of the Society certain sheets of the 1-inch and half-inch Topographical Maps prepared by the Australian Military Survey Section, which were not put on sale but retained under military control for official use only, so that in accordance with custom they have not been referred to in any of our publications. In response to an inquiry recently addressed to the Secretary of the Department of Defence, we are informed by him in a letter dated 22 March 1935 that there is now no objection to the inclusion of these maps in any notice of publications, and that they are on sale to the public in Australia through authorized agents appointed in the capital cities of the States at the price for the 1-inch map of 2*s*. unmounted, 4*s*. mounted on linen: the ½-inch are 3*s*. and 6*s*. respectively.

The Australian Survey Corps, by whom the sheets are now prepared for the Australian Section of the Imperial General Staff, is a small but highly trained unit of the Permanent Military Forces of the Commonwealth with a present establishment of four officers and fifteen other ranks. The unit is organized into one draughting section, and three field-survey sections, and with its present strength produces maps covering some 2500 square miles per annum. It is hoped to increase the establishment so that 20,000 square miles per year may be covered. The printing and photographic work are done by the Government Printer at Melbourne.

Of the 1-inch map we have received 24 sheets of New South Wales, 8 of Queensland, 1 of South Australia, 18 of Victoria, 7 of Western Australia. and 1 sheet of the Federated Territory: of the ½-inch map, 1 of New South Wales, 1 of Queensland, and 3 of Victoria.

Both maps are $28\frac{1}{2} \times 17\frac{1}{2}$ inches on the engraved surface. Both are contoured in red at 50-foot intervals, have water in blue, and timber and scrub in green. The half-inch map covers 1° of longitude by ½° of latitude, and is divided into a mesh 10′ × 10′ with each mesh divided into five rows of four numbered quadrilaterals, each of which is divided into four lettered quarters.

The one-inch map on the other hand has a rectangular grid of 1000 yards with instructions for grid referencing to the nearest 100 yards. There are also red and blue figures in the top and bottom margins of the map which are described as "for artillery purposes," and whose meaning is not plain. The sheets are well engraved and cleanly printed, and have all the advantages in representation of a country in which there are very few names. The grid numbers which are repeated from the margin over the face of the map somewhat destroy its beauty, but are in the inch map very carefully drawn to be clear and unobtrusive. Every one will hope that the establishment of the Survey Corps may be so increased that the output now contemplated may be secured, for Australia is a large country to cover with 1 inch or even ½ inch sheets.

MEETINGS: SESSION 1934-35

Twelfth Evening Meeting, 29 April 1935. The President in the Chair

Elections: Jamal ud Din Ahmad, B.A.; Sydney Dearman Brace; H. J. Crocker; Alfred Proom Humble, A.M.INST.C.E., M.I.STRUCT.E.; Mrs. John Norris; Captain Charles William Knowles Pfeiffer, R.A.; Major F. W. H. Pratt, M.C., R.A.

Paper: Floods and Flood-Control in China and America. By Professor George Barbour

Thirteenth Evening Meeting, 13 May 1935. The President in the Chair

Elections: Edward Addenbrooke, B.A.; William George Beare, F.C.P.; Miss Beatrice May Crawford Beeforth; Monseigneur le Duc Charles Eugène Gascons d'Allery de Prony; Arthur Geddes, D. es L.; C. Hartley; John Harding McBride, B.SC.; Lieut. Charles Peter Warwick Marshall, R.N.; William Owen Williams

Paper: Progress of Geography in the Field and in the Study during the Reign of His Majesty King George the Fifth. By the Rt. Hon. Sir Halford Mackinder

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